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Award Number: W81XWH-04-1-0321

TITLE: Cybertherapy 2004: Using Interactive Media in Training and Therapeutic Interventions

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REPORT DATE: March 2005

TYPE OF REPORT: Final Proceedings

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

DISTRIBUTION STATEMENT: Approved for Public Release;
Distribution Unlimited

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20050516 054

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY

2. REPORT DATE
March 2005

3. REPORT TYPE AND DATES COVERED
Final Proceedings (10 Feb 04 - 10 Feb 05)

4. TITLE AND SUBTITLE
Cybertherapy 2004: Using Interactive Media in Training and Therapeutic Interventions

5. FUNDING NUMBERS
W81XWH-04-1-0321

6. AUTHOR(S)

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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

Original contains color plates: ALL DTIC reproductions will be in black and white

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release; Distribution Unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 Words)

The 9th Annual CyberTherapy Conference was originally held as part of the Medicine Meets Virtual Reality Conference, beginning in 1996 with a half-day symposium, and a few presentations mostly concerning conceptual matters and future possibilities. I am happy to report that after 9 years, we have progressed to a three-day conference, accompanied by a full day of pre-conference workshops on specialty topics. This conference encompasses the largest collection of clinical trials for advanced technologies in mental health, rehabilitation, and disabilities. It is our specific intention to bring together the best clinicians and researchers with representatives from funding agencies that are interested in applying advanced technologies to improve healthcare.

14. SUBJECT TERMS

Cybertherapy, virtual reality, simulation, cognitive therapy

15. NUMBER OF PAGES
219

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

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Introduction

Cybertherapy can be considered the integration of telehealth technologies with the Internet and shared virtual reality. Although cybertherapy is a branch of telehealth, it is differentiated in several important ways: telehealth to date has been largely non-Internet based and has been characterized by point-to-point (e.g., T1) and dial-up (e.g., telephone, ISDN) information exchange.

Cybertherapy, on the other hand, is more accessible due to the integrated use of shared media. Using the Internet and virtual reality tools the therapists may present, from a remote site, a wide variety of stimuli and to measure and monitor a wide variety of responses made by the user.

In general, there are two reasons why cybertherapy is used: either because there is no alternative, or because it is in some sense better than traditional medicine. Up to now the benefits of cybertherapy - due to the variety of its applications and their uneven development - are not always self-evident.

However, the Cybertherapy 2004 conference wants to show that the emergence of cybertherapy trials is supporting the cost-effectiveness of certain applications, such as neuroscience, rehabilitation and clinical psychology. Its key advantage is the possibility of sharing different media and different health care tools in a simple to use and easily accessible interface.

Particular attention will be given to the clinical use of virtual reality technology. An important part of this overview are the clinical results coming from the European Union VEPSY Updated - Telemedicine and Portable Virtual Environments for Clinical Psychology - research project (IST-2000-25323 - http://www.cybertherapy.info). More in detail, the conference presentations will show that different cybertherapy applications have improved the quality of health care, and later they will probably lead to substantial cost savings.

However, cybertherapy is not simply a technology but a complex technological and relational process. In this sense, clinicians and health care providers that want to successfully exploit these tools need a significant attention to clinical issues, technology, ergonomics, human factors and organizational changes in the structure of the relevant health service.

To spread the diffusion of cybertherapy, further research is needed. More evaluation is required of clinical outcomes, organizational effects, benefits to health-care providers and users, and quality assurance. It is also very important that professionals in this field share information about their experience and examine the results of evaluations so that the suitable development work can be speeded up.

In conclusion, the goal of this conference is to analyze and discuss the processes by which cybertherapy applications can contribute to the delivery of state-of-the-art health services. We expect that the contents of this conference will stimulate more clinicians and technical professionals in finding new solutions in order to expand their intervention interests and in making better use of the innovative cybertherapy tools.

Body

These proceedings consist of selected papers from the Ninth Annual CyberTherapy Conference: Interactive Media in Training and Therapeutic Interventions. The CyberTherapy Conference evolved from the Advanced Technologies in Mental Health/Rehabilitation Symposium that was held as part of the Medicine Meets Virtual Reality (MMVR) Conference for seven years. Because of the growth experienced by the Advanced Technologies in Mental Health/Rehabilitation Symposium, it was decided that the symposium should be expanded into its own separate conference organized by the Interactive Media Institute, a nonprofit corporation that helps educate the public and disseminate information on the uses of advanced technologies in the fields of mental health, rehabilitation, and disabilities. The conference was held on January 10-12, 2004 in San Diego, California and was attended by distinguished researchers and clinicians from thirteen different countries.

This year's response to the conference's call for papers was incredible, causing organizers to add a day of workshops prior to the conference. The research was of superior quality, and the topics presented spanned numerous areas in the virtual reality and mental health fields. The array of expertise fostered an environment conducive to active discussion and debate between scientists, leading to a wonderful distribution and sharing of ideas.

In the first paper, Viaud-Delmon, Seguelas, & Rio, et al. discuss the importance of auditory feedback in VR systems for

clinical use. Two virtual environments, visual alone and auditory-visual, compared normal subjects and agoraphobic patients. Normal subjects reported a better sense of presence and realism in the auditory-visual environment. However, agoraphobic patients experienced more cybersickness in this condition, possibly due to a multisensory integration deficit of anxious patients. This reveals one of many factors that need to be taken into account when building a bimodal virtual environment.

The second paper, written by Viciana-Abad, Reyes-Lecuona, & García-Berdonés, et al., focuses on the relationship between significant information, presence, and stress in virtual environments. The results of the study suggest a strong, close relationship between increments of stress and presence, and that each element could be cause and consequence of the other.

Next, Rand, Kizony, & Brown, et al. comment on the differences in sense of presence, performance and perceived exertion. Users engaged in two games within virtual environments that differed in their level of structure and spontaneity. It was found that both structured and non-structured environments can be a helpful intervention tool in rehabilitation, though one may be preferable over the other depending on the patient's gender, the therapeutic objectives, and other factors.

The fourth paper, by Riva, Alcañiz, & Anolli, et al., is an update on the status of the VEPSY Project. The goal of the project is to develop different PC-based virtual reality modules to be used in clinical assessment and treatment of social phobia, panic disorders, male sexual disorders, obesity, and eating disorders. The current head-mounted display (HMD), two-button joystick, and software technologies are presented, as well as the success of VR when integrated with traditional psychotherapy approaches.

The next article is written by Gaggioli, di Carlo, & Mantovani, et al. of the Istituto Auxologico Italiano in Milan, Italy. It outlines the history and current state of telemedicine in Italy, focusing on physicians' attitudes. The article encourages increased circulation of information on new technologies and a focus on the benefits for the patient, with the goal of allowing telehealthcare to grow in popularity.

The following paper, by Csukly, Simon, Kiss, and Takács, describes a psychiatric assessment tool that animates 3D faces

of virtual humans in real-time to evoke and measure emotional responses of psychiatric patients. The patients' ability to recognize basic expressions (such as neutral, happiness, surprise, fear, anger, disgust, or sadness) of the photorealistic models is used as an indication of their mental health, and mapped onto scientifically evaluated symptoms of the respective brain disorders. Early clinical results demonstrate that the new assessment tool can be effectively used to screen patients for a group of well-defined psychiatric disorders.

Klinger, Chemin, Lebreton, and Marié's article reports on a virtual supermarket in which patients with Parkinson's disease and control subjects were tested on precision and efficiency in a real-world situation. There was no significant difference between patients and control subjects for the number of correct actions, which suggests that global access to the semantic knowledge of the script is normal in Parkinson's patients. However, more specific measures such as distance, duration, number of stops, and recorded trajectory allow for precision in identifying the planning alteration in Parkinson's. Continued VR techniques are expected to allow significant progress in the prediction of action planning in everyday life, as well as assist in rehabilitation relevant to patients' real worlds.

Another issue for aging patients is joint disease, as Kline-Schoder, Kane, & Fishbein, et al. have focused on. Physical therapy is an effective treatment, though the accompanying pain discourages many patients. Kline-Schoder & colleagues have proven here that using VR to distract patients from pain during treatment and physical therapy is effective, and enjoyed by the patients.

Lockerd, Brisben, and Lathan are working with child rehabilitation using their system CosmoBot™, an interactive Robot toy, and Mission Control, an adaptive control interface which allows users to control CosmoBot™ using gesture and voice. These systems have been used with children undergoing various types of rehabilitation therapies, including physical, occupational, and speech/language therapy. The system was determined to be a useful motivational tool, targeting a number of therapeutic and educational goals.

Inspired by the positive effects of animal/human interaction on humans, Shibata, Wada, Saito, and Tanie have developed an interactive robot for therapeutic purposes in the form of a realistic baby seal. "Paro" was presented in a health care

facility for the elderly for three weeks, and in response subjects' moods improved as measured by face scales, the Profile of Mood States questionnaire, and comments from the nursing staff. This was compared with a "placebo Paro" which merely repeated a string of actions and sounds rather than reacting to subjects' behavior. Surprisingly, both robots were effective in improving mood and alleviating depression, perhaps because the subjects did not notice the difference or were not interested in the mechanisms behind Paro's performance.

Next, Steffin and Wahl address the problem of air and automotive accidents caused by drowsiness. They offer a real-time on-road alertness monitor consisting of two laterally mounted cameras outside the driver's field of view. The output from the cameras is processed to measure the frequency and duration characteristics of the driver's head position in relation to a standard driving position correlated behaviorally with alertness. Eye and mouth positions and motions are also analyzed and checked for patterns of eye opening and closing and yawning.

Mager, Stoermer, & Estoppey, et al. research the effects of sleep deprivation on 41 professional and "normal" drivers using a real-car based static augmented reality driving simulator. The simulator measured the performance state, and subjects' vigilance was measured using electroencephalography (EEG). When drowsiness was detected, a warning was given by the Driver Warning System, and subjects' levels of vigilance returned in response.

St. Germain, Kurtz, Pearlson, and Astur created a desktop driving simulator to test driving skills and see how an individual would respond to everyday driving hazards (e.g. children running in front of the car, cars running red lights, car running a stop sign, etc.). The hypothesis was that people diagnosed with schizophrenia would, as a group, display driving impairments. Schizophrenic subjects did in fact make more errors in crossing white and yellow lines, and showed a trend towards more collisions despite driving significantly slower than control subjects. This suggests that patients' real-life driving may be impaired as well.

In the next paper, Tarnanas and Manos deal with the development and evaluation of two different virtual reality cognitive-behavioral treatment settings and compare their effectiveness in disaster preparedness and acute stress response (ASR). The two basic modes of interaction are a guided "storytelling" mode and

an interactive mode where the participant controls his or her navigation/actions in a simulated earthquake. Children who had and had not previously experienced medium-sized earthquakes comprised the subject groups. The interactive mode was found to be particularly helpful when familiar faces were included in the simulation, as the child's level of fear was affected by other students' levels of fear.

After that, Hayes-Roth, Amano, Saker and Sephton discuss their system, STAR™ Workshop, which is intended to help clinicians gain training in brief intervention techniques for patients with alcohol or substance abuse problems. STAR™ is an online training workshop incorporating a virtual coach and virtual standardized patients. The coach motivates and teaches an evidence-based brief intervention protocol, and virtual patients provide practice and intrinsic reinforcement. After each practice session, the coach offers additional feedback and any needed remediation. The STAR workshop was evaluated in comparison to a self-paced E-book containing the same content and a control group with no training. Subjects trained with STAR Workshop substantially outperformed subjects in the other conditions, indicating that this system may be an effective and affordable method for training brief intervention skill in alcohol abuse.

Ng and Wiemer-Hastings explore internet addiction and conduct a survey comparing players of offline video games and players of Massively Multiplayer Online Role-Playing Games (MMORPGs). Those who play MMORPGs spent significantly more time in-game, and stated that they are happiest in-game and would choose it over interaction with real life friends. However, it was found that it is the social aspects that exist in-game that draw users into MMORPG's. Even with high usage times, MMORPG users cannot be categorized as addicted, because they do not exhibit the behaviors of addicts.

Key Research Accomplishments

The CyberTherapy 2004 meeting brought together the world's leaders in clinical application of virtual reality. This conference resulted in the publication of numerous scientific papers, which are reproduced in the proceedings.

Reportable Outcomes

The outcomes of this conference resulted in significant dissemination of scientific information. In addition, the success

of this conference has resulted in the next conference, CyberTherapy 2005, which is being held in Basel Switzerland.

Conclusions

The scientific results of this conference are published in the Proceedings of The 9th Annual CyberTherapy Conference.

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Wiederhold, B., Riva, G., Wiederhold, M., Proceedings of The 9th Annual CyberTherapy Conference, January 10-12, 2004, Westgate Hotel, San Diego, California, Published by Interactive Media Institute, ISBN: 0-9724074-3-X.

Appendices

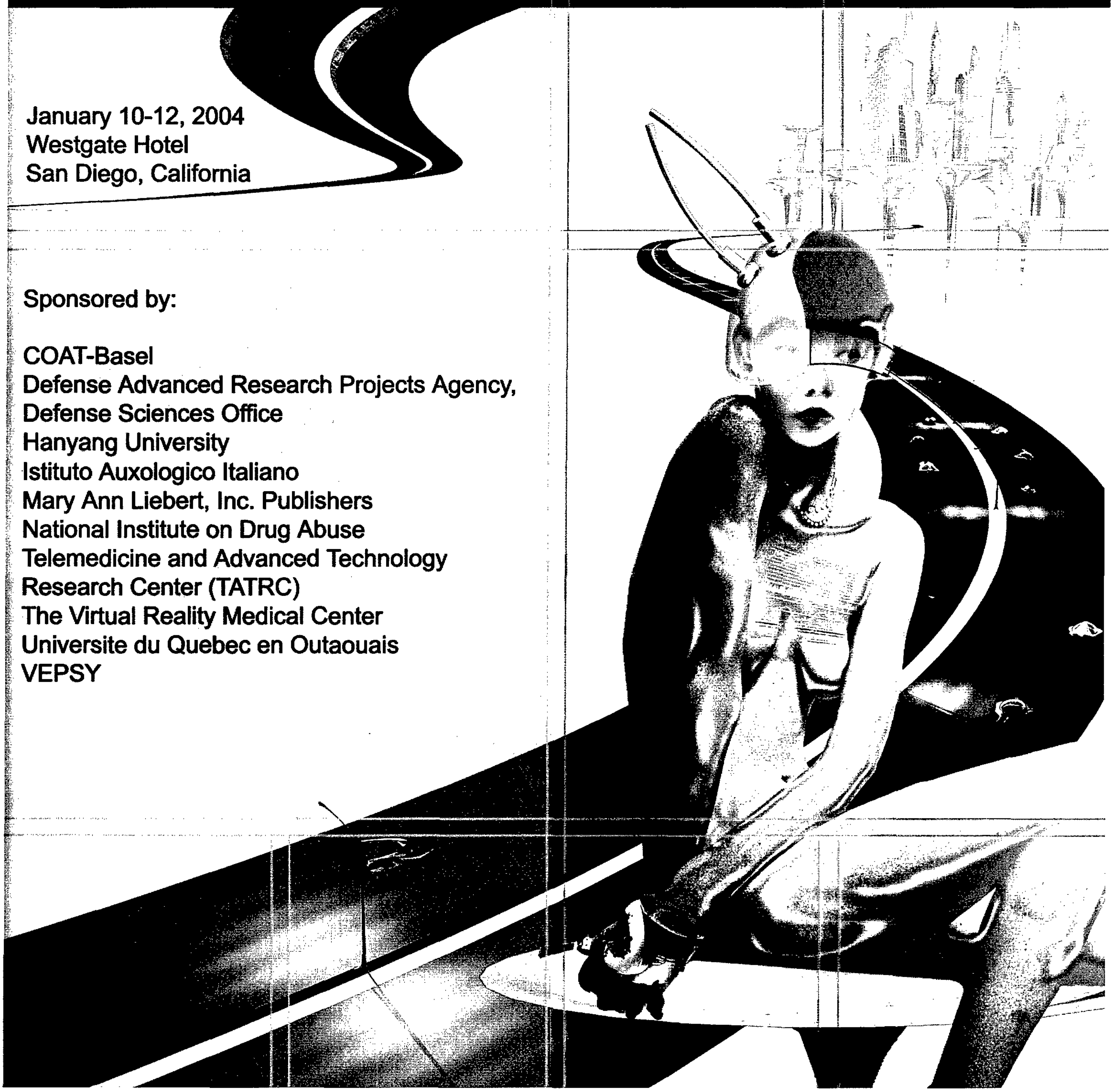
Proceedings enclosed.

Proceedings of

The Ninth Annual CyberTherapy Conference 2004

Organized by: Interactive Media Institute

January 10-12, 2004
Westgate Hotel
San Diego, California



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Defense Advanced Research Projects Agency,
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National Institute on Drug Abuse
Telemedicine and Advanced Technology
Research Center (TATRC)
The Virtual Reality Medical Center
Universite du Quebec en Outaouais
VEPSY

CyberTherapy

Interactive Media in Training and Therapeutic Interventions

Editors:
B. Wiederhold
G. Riva
M. Wiederhold

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Interactive Media Institute
6160 Cornerstone Court East
San Diego, CA 92121

Cover Design by Laycee Fan and John Law
Edited by Kathleen Mitchell
Text Design by Ruth Kogen and Laura Paajanen

ISBN: 0-9724074-3-X

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Printed in the United States of America

Interactive Media Institute Web site Address: www.vrphobia.com/imi or www.interactivemediainstitute.com

Acknowledgements

It would not be possible to organize and hold this conference without the significant financial support of our sponsors. We recognize both their financial and organizational help in these efforts. Specifically we thank:

COAT-Basel
Defense Advanced Research Projects Agency, Defense Sciences Office
Hanyang University
Istituto Auxologico Italiano
Mary Ann Liebert, Inc. publishers
National Institute on Drug Abuse
Telemedicine and Advanced Technology Research Center
The Virtual Reality Medical Center
Université du Québec en Outaouais
VEPSY

In addition, we would like to thank the individuals who made this year's conference possible: the Program Committee for their help in reviewing abstracts, the many helpful comments and suggestions, and intellectual support. And finally, thank you to the volunteers from the Virtual Reality Medical Center, Interactive Media Institute, Istituto Auxologico, and Applied Technology for Neuropsychology Lab who helped make this conference a reality. A special thank you to Ruth Kogen for her organizational abilities and efforts to keep us all on track with the proceedings and hundreds of other details. We also wish to thank Lei "Laycee" Fan and John Law for designing this year's conference materials.

We appreciate your attendance and participation in this conference and hope it serves to stimulate new ideas and collaborations amongst members of our community.

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This year we note that over half of the presenters are new and have not attended any of the previous conferences. This trend confirms that the use of virtual reality, simulation, and other advanced technologies continues to attract new researchers from around the globe who bring exciting new ideas and applications to further this area of investigation.

I look forward to the opportunity to meet friends and colleagues from past conferences as well as greeting our new attendees and guests. We have already begun planning for CyberTherapy 2005, where we will continue to engage the international interest of clinicians, researchers, and representatives from a variety of governmental and private funding agencies. We hope you find this year's conference a rewarding and intellectually stimulating experience. We look forward to seeing you again next year at the 10th annual CyberTherapy Conference to be held the 1st week in June 2005 in Switzerland.

Sincerely,

Brenda K. Wiederhold, Ph.D., MBA, BCIA
2004 Program Chair
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Proceedings Overview

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The following paper, by Csukly, Simon, Kiss, and Takács, describes a psychiatric assessment tool that animates 3D faces of virtual humans in real-time to evoke and measure emotional responses of psychiatric patients. The patients' ability to recognize basic expressions (such as neutral, happiness, surprise, fear, anger, disgust, or sadness) of the photorealistic models is used as an indication of their mental health, and mapped onto scientifically evaluated symptoms of the respective brain disorders. Early clinical results demonstrate that the new assessment tool can be effectively used to screen patients for a group of well-defined psychiatric disorders.

Klinger, Chemin, Lebreton, and Marié's article reports on a virtual supermarket in which patients with Parkinson's disease and control subjects were tested on precision and efficiency in a real-world situation. There was no significant difference between patients and control subjects for the number of correct actions, which suggests that global access to the semantic knowledge of the script is normal in Parkinson's patients. However, more specific measures such as distance, duration, number of stops, and recorded trajectory allow for precision in identifying the planning alteration in Parkinson's. Continued VR techniques are expected to allow significant progress in the prediction of action planning in everyday life, as well as assist in rehabilitation relevant to patients' real worlds.

Another issue for aging patients is joint disease, as Kline-Schoder, Kane, & Fishbein, et al. have focused on. Physical therapy is an effective treatment, though the accompanying pain discourages many patients. Kline-Schoder & colleagues have proven here that using VR to distract patients from pain during treatment and physical therapy is effective, and enjoyed by the patients.

Lockerd, Brisben, and Lathan are working with child rehabilitation using their system CosmoBot™, an interactive Robot toy, and Mission Control, an adaptive control interface which allows users to control CosmoBot™ using gesture and voice. These systems have been used with children undergoing various types of rehabilitation therapies, including physical, occupational, and speech/language therapy. The system was determined to be a useful motivational tool, targeting a number of therapeutic and educational goals.

Inspired by the positive effects of animal/human interaction on humans, Shibata, Wada, Saito, and Tanie have developed an interactive robot for therapeutic purposes in the form of a realistic baby seal. "Paro" was presented in a health care facility for the elderly for three weeks, and in response subjects' moods improved as measured by face scales, the Profile of Mood States questionnaire, and comments from the nursing staff. This was compared with a "placebo Paro" which merely repeated a string of actions and sounds rather than reacting to subjects' behavior. Surprisingly, both robots were effective in improving mood and alleviating depression, perhaps because the subjects did not notice the difference or were not interested in the mechanisms behind Paro's performance.

Next, Steffin and Wahl address the problem of air and automotive accidents caused by drowsiness. They offer a real-time on-road alertness monitor consisting of two laterally mounted cameras outside the driver's field of view. The output from the cameras is processed to measure the frequency and duration characteristics of the driver's head position in relation to a standard driving position correlated behaviorally with alertness. Eye and mouth positions and motions are also analyzed and checked for patterns of eye opening and closing and yawning.

Mager, Stoermer, & Estoppey, et al. research the effects of sleep deprivation on 41 professional and "normal" drivers using a real-car based static augmented reality driving simulator. The simulator measured the performance state, and subjects' vigilance was measured using electroencephalography (EEG). When drowsiness was detected, a warning was given by the Driver Warning System, and subjects' levels of vigilance returned in response.

St. Germain, Kurtz, Pearlson, and Astur created a desktop driving simulator to test driving skills and see how an individual would respond to everyday driving hazards (e.g. children running in front of the car, cars running red lights, car

running a stop sign, etc.). The hypothesis was that people diagnosed with schizophrenia would, as a group, display driving impairments. Schizophrenic subjects did in fact make more errors in crossing white and yellow lines, and showed a trend towards more collisions despite driving significantly slower than control subjects. This suggests that patients' real-life driving may be impaired as well.

In the next paper, Tarnanas and Manos deal with the development and evaluation of two different virtual reality cognitive-behavioral treatment settings and compare their effectiveness in disaster preparedness and acute stress response (ASR). The two basic modes of interaction are a guided "storytelling" mode and an interactive mode where the participant controls his or her navigation/actions in a simulated earthquake. Children who had and had not previously experienced medium-sized earthquakes comprised the subject groups. The interactive mode was found to be particularly helpful when familiar faces were included in the simulation, as the child's level of fear was affected by other students' levels of fear.

After that, Hayes-Roth, Amano, Saker and Sephton discuss their system, STAR™ Workshop, which is intended to help clinicians gain training in brief intervention techniques for patients with alcohol or substance abuse problems. STAR™ is an online training workshop incorporating a virtual coach and virtual standardized patients. The coach motivates and teaches an evidence-based brief intervention protocol, and virtual patients provide practice and intrinsic reinforcement. After each practice session, the coach offers additional feedback and any needed remediation. The STAR workshop was evaluated in comparison to a self-paced E-book containing the same content and a control group with no training. Subjects trained with STAR Workshop substantially outperformed subjects in the other conditions, indicating that this system may be an effective and affordable method for training brief intervention skill in alcohol abuse.

Ng and Wiemer-Hastings explore internet addiction and conduct a survey comparing players of offline video games and players of Massively Multiplayer Online Role-Playing Games (MMORPGs). Those who play MMORPGs spent significantly more time in-game, and stated that they are happiest in-game and would choose it over interaction with real life friends. However, it was found that it is the social aspects that exist in-game that draw users into MMORPG's. Even with high usage times, MMORPG users cannot be categorized as addicted, because they do not exhibit the behaviors of addicts.

For more information about the CyberTherapy 2004 conference, please visit www.vrphobia.com/imi. My sincere thanks to all of those who participated and helped to organize this year's meeting.

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3-D Sound and Virtual Reality: Applications in Clinical Psychopathology

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Abstract: *The aim of this study was to provide information about the importance of auditory feedback in a VR system planned for clinical use, and to address the different factors that should be taken into account in building a bimodal virtual environment. We conducted an experiment in which we assessed spatial performances in agoraphobic patients and normal subjects, comparing two kinds of virtual environments: visual alone (Vis) and auditory-visual (AVis), during separate sessions.*

Subjects were equipped with a head-mounted display coupled with an electromagnetic sensor system and immersed in a virtual town in which they could move forward by pressing a mouse button. Subjects had to turn on their own vertical axis in order to change the direction of heading in the virtual town. Their task was to locate different landmarks and become familiar with the town. In the AVis condition subjects were equipped with the head-mounted display and headphones, which delivered a soundscape updated in real time according to their movement in the virtual town. The sounds were produced through tracked binaural rendering (HRTF).

The two groups of subjects exhibited better scores of presence in the AVis condition, although patients exhibited more cybersickness symptoms than normal subjects in this condition. While normal subjects preferred the AVis condition, expressing a better sense of realism, patients did not mention such a preference. Overall, this study might reflect the multisensory integration deficit of anxious patients and underline the need for further research on multimodal VR systems for clinical use.

INTRODUCTION:

The specific feature of VR compared to traditional displays is that the environments it provides are places where as many senses as possible are meant to be active. "Multisensory" is a keyword for virtual reality. The number of sensory modalities through which the user is coupled to the virtual environment is a main factor contributing to the feeling of presence. In spite of that, VR technologies rarely integrate the auditory modality, which is the only sense through which we are communicating with the whole space around us.

Psychiatric patients commonly report a hypersensitivity to auditory stimuli, while pure tone audiograms show generally normal hearing. Sound tolerance is influenced by stress and tiredness, and specific sounds can cause physical pain and nerve grating[1]. There is a correlation between loudness tolerance and anxiety[2], and strong emotional reactions can easily be elicited through hearing[3]. It is therefore all the more interesting to integrate the auditory modality in a realistic way when working with anxious patients, and to understand in which way it can be used for therapeutic purposes.

Several studies have led to the observation that patients with agoraphobia, panic disorder, or space and motion discomfort (SMD) may have a problem with multisensory integration: subjects with symptoms of panic disorder and agoraphobia are destabilized under conflicting sensory conditions while maintaining upright posture[4, 5, 6]. Previous studies creating conflicts between vestibular and visual information with a VR setup attempted to demonstrate that abnormal central processes of multisensory integration in maintaining balance in anxiety disorders was not restricted to balance control[7, 8]. By inte-

grating the auditory modality to a VR setup, it is a more general question as to whether multisensory integration in anxiety can be addressed. Without any additional sensory conflict than the one which is inherent to a VR set-up (due to the delay in feedback between action and consequences of actions in the virtual environment –VE), how do anxious patients cope with interactive auditory modality? Would the introduction of the auditory modality generate sensory enhancement or sensory overload?

The study we present here involves technologies, models and applications linked to the introduction of 3D sound in virtual or augmented reality environments. Auditory augmentation of visual environments is known to improve presence and immersion. It also appears very promising in creating user-friendly information systems accessible to everybody. To create such an environment and the corresponding content, several concepts and technologies need to be researched, developed, and/or integrated. The introduction of 3D sound modality also addresses the need for a better understanding of multisensory integration mechanisms. This includes complementarities or conflict between the auditory and visual senses and also with idiothetic cues (cues generated through self-motion, including vestibular and proprioceptive information). These last aspects are important since many applications can now involve user navigation in a virtual or augmented world, or perception-action cues provided by interactive devices.

The most natural audio technique for virtual reality applications is the binaural rendering on headphones that relies on the use of HRTFs (HRTF refers to Head Related Transfer Function, which is a set of filters measured on an individual or artificial head and used to reproduce all the directional cues involved in auditory localization). This technique still needs some studies to overcome its implementation cost and individual adaptation limitations (a fully convincing spatial rendering requires the use of HRTFs measured on the listener's head).

Incorporating real-time updated 3-D sound to virtual reality technologies therefore addresses several practical issues. If there is a consensus on the fact that presence is improved by 3-D sound, little is known about how an auditory VE should be designed so that it does not interfere with the visual VE. We thus conducted a study to provide information about the importance of auditory feedback in a VR system planned for clinical use, as well as one which would provide information about the different factors which should be taken into account to build a multimodal VE (sense of realism, presence, and coherence between the visual and auditory VE).

If agoraphobic patients are effectively more sensitive to sensory conflicts than normal subjects, then multisensory feedback in VR could represent a challenge for them. However, since presence during a bimodal stimulation should be higher, this might provide an interesting way to convey supplementary spatial information and engage patients in a task. We conducted a study in which we compared navigation performances in a virtual town in two immersive conditions: visual alone (Vis) and auditory-visual (AVis). We intended to test the emotional and behavioral reaction of patients sensitive to space and of normal subjects to these two kinds of virtual stimulation in order to develop new procedures and find an integrated approach to work with vision and audition in VR.

MATERIAL AND METHODS:

Design

All subjects included in the comparative study received two sessions of virtual navigation. The order of sessions was counterbalanced so that the same number of subjects began the trial with AVis and Vis conditions. Sessions were performed at least one week apart. After each session, subjects had to complete several questionnaires and 2 memory tests related to their experience. In the first test, they were presented a survey view of the virtual town and had to locate the different landmarks they were asked to find during navigation. In the second test, they were submitted to a 2-choice forced recognition task, during which they were presented 10 pairs of snapshots and were required to chose between a view taken in the virtual town they had navigated in and a view taken in another town.

The measures taken during the navigation were the number of landmarks found (score on 11) and the time spent in the virtual town. The measures taken after navigation were the num-

ber of correctly localized landmarks on the survey view of the virtual town (score on 12) and the number of correct answers to the 2-choice forced recognition task (score on 10). Participants were debriefed after each session but were not informed about the content of the following session. At the end of the second session and after the debriefing they were informed about the differences between the two conditions if they had not noticed it.

Procedure

Subjects were equipped with a head-mounted display coupled with an electromagnetic sensor system and immersed in the virtual town in which they could move forward by pressing a mouse button. Subjects had to turn on their own vertical axis in order to change the direction of heading in the virtual town. Their task was to locate different landmarks (movie theater, swing, bus stops, see Figure 1) and become familiar with the town. In the AVis condition subjects were equipped with the head-mounted display and headphones, which delivered a soundscape updated in real time according to their movement in the virtual town. The sounds were produced through tracked binaural rendering (non-individual HRTF) and were dependent upon the subject's movements.

Subjects

Patients were individuals suffering from agoraphobia as their main complaint. Seventeen patients were referred to us for the study at the local day hospital (12 females, 5 males). Two of them were excluded from the following analysis since their fear of empty spaces was so severe that they could not accomplish the task. Five patients stopped the protocol after the first session (3 females, 2 males). The remaining 10 patients completed the project (7 females, 3 males). Nine control subjects (7 females, 2 males) were included in the study. The mean ages of the anxious and control samples were 35.3 (SD 10.2) and 32.7 years (SD 10.6), respectively. The control participants were not

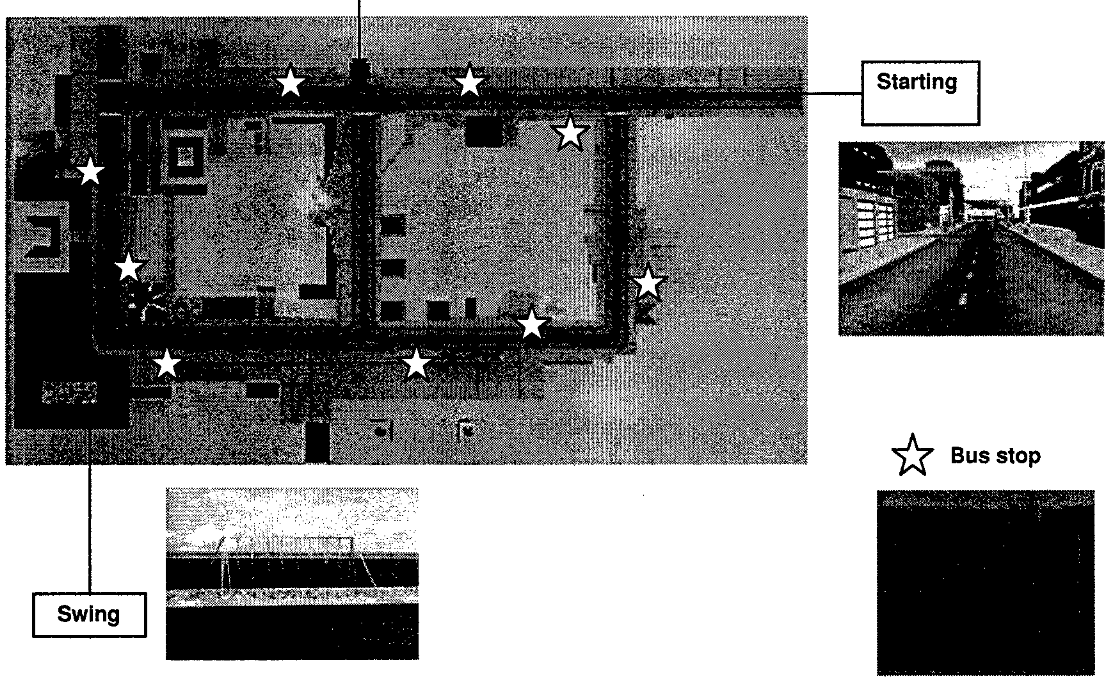

Figure 1. Survey view of the Visual Environment in Vis and AVis conditions.
The subject's task is to find the movie theater, then the swing, then to count how many bus stops there are in this virtual town. The subject stops navigating when he/she thinks that he/she is familiar with the town and that he/she has localized all the targets.

afflicted with any mental disorders. A semi-structured interview based on the Mini International Neuropsychiatric Interview was administered to all the participants to ensure that they met these criteria.

Questionnaires and Interview Measures

The state portion[9] of the STAI was used to measure the anxiety levels upon arrival at the laboratory and after completion of the experiment. A 22-item cybersickness scale was used to assess the level of discomfort after exposure to VR. It comprised a list of symptoms and sensations associated with autonomic arousal (nausea, sweating, heart pounding, etc.), vestibular symptoms (dizziness, fainting, etc.), respiratory symptoms (feeling short of breath, etc.) and could also be used to estimate signs of somatisation (tendency to complain of a large number of diverse symptoms). Items were rated on a scale from 0 to 4 (absent, weak, moderate, strong). The presence questionnaire from the I-group[10] was presented after completion of the experiment.

Visual and Auditory stimuli

The 3D visual environment was based on a 3D model developed by Sense8 Corp (San Rafael, CA). It was composed of noticeable landmarks, several streets and alleys, and was rendered using Virtools Dev 2.5 (Virtools SA, Paris, France). This software has limited features in terms of auditory design, which consists mainly of stereo rendered sources, even if specific plug-ins may be also implemented. In order to allow the maximum flexibility with regards to sound design, we used the Spat~ sound rendering engine[11, 12] and the ListenSpace auditory scene authoring tool[13]; both developed at Ircam. A specific network interface was developed in order to connect Virtools with ListenSpace and Spat~, enabling the transmission of position coordinates and rotation angles of the user's head in the virtual world. The sounds were produced through tracked binaural rendering (HRTFs) and were dependent upon the subject's movements.

The model used for the audio environment was almost static; sound sources and their activation zones did not move. Only the movement and position of the subject drove audio events and their spatialization according to their relative coordinates. Two types of auditory elements were used; *binaurally rendered monophonic sources* and *ambisonics sound scenes* (Figure 2). *Binaurally rendered monophonic sources* were put at precise locations in the scene. The ListenSpace environment made it possible to program the position of these sources, and to define the small activation areas where the sources could be heard. *Ambisonics sound scenes*, linked to large activation areas, were added to the soundscape. Ambisonics is a 4 channel audio format that embodies spatial information of a sound scene according to the 3 directions of space (left/right, front/back and up/down), thus allowing a full immersion of the listener inside an auditory environment. The ambisonics sound scenes were recorded using the dedicated ST 250 Soundfield microphone in an urban environment, which corresponded well to the visual context of the experiment. These sound scenes were decoded in real time for a reproduction over headphones, according to the listener's position in the virtual space. The large activation areas covered the whole town, so that the subject was either at the center of at least one sound scene, or in a cross-fade region between two sound scenes. The cross-fade mechanism was tuned to ensure smooth transitions between the 4 sound scenes.

Virtual Reality Set-Up Specifications

We used a V8 head-mounted display (Virtual Research Systems, Santa Clara, CA). The LCD displays had a monocular field of view of 48° by 36°, with an array of 640x480 (true VGA) color triads (pixels), refreshed at 60 frames per second. The subject's head orientation was measured by an electromagnetic sensor system (Fastrak Polhemus) which has an update rate of 120 Hz. The image generator (Pentium IV 2.4GHz, 512 megabytes of RAM and an NVIDIA Quadro4 750 XGL graphics card) took the head angular position information from the tracker and sent the corresponding image to the display and to ListenSpace (Pentium IV 2.4GHz), which calculated the position of the sound sources with respect to the head angular position information and sent them to the Spat~ (Mac 1GHz), which generated the sound. The Mac was equipped with a Hammerfall DSP system. Sennheiser HD570 circum-aural open headphones were used in the AVis condition.

Statistical analysis

To assess the effect of auditory modality in the procedure, repeated measures ANOVAs (2 x 2) were performed on the different scores as the dependent variable, with condition (Vis and AVis) as a within-subjects factor and with group (patients and control) as between-subjects factor. The effect of VR session on state anxiety was evaluated with repeated measures ANOVAs (2 x 2 x 2). To check for a potential presentation order of conditions effect on the different variables, repeated measures ANOVAs (2 x 2) were performed on the different scores as the dependent variable, with presentation order of conditions (Vis first and AVis first) as a between-subjects factor and with condition (Vis and AVis) as a within-subjects factor. Non-parametric statistical tests were used when needed.

RESULTS:

Of the 17 recruited patients, as mentioned before 2 females had to be excluded because of strong emotional reactions. Interestingly, the protocol served as a therapy for the two of them, who eventually managed to perform part of the navigation task at the end of the second session (with 2 landmarks found). Five patients completed only one session. Two did an AVis condition (2 females), 3 did a Vis condition (1 female, 2 males). Only the 10 patients who completed two sessions were included in the comparative analysis (see Table 1).

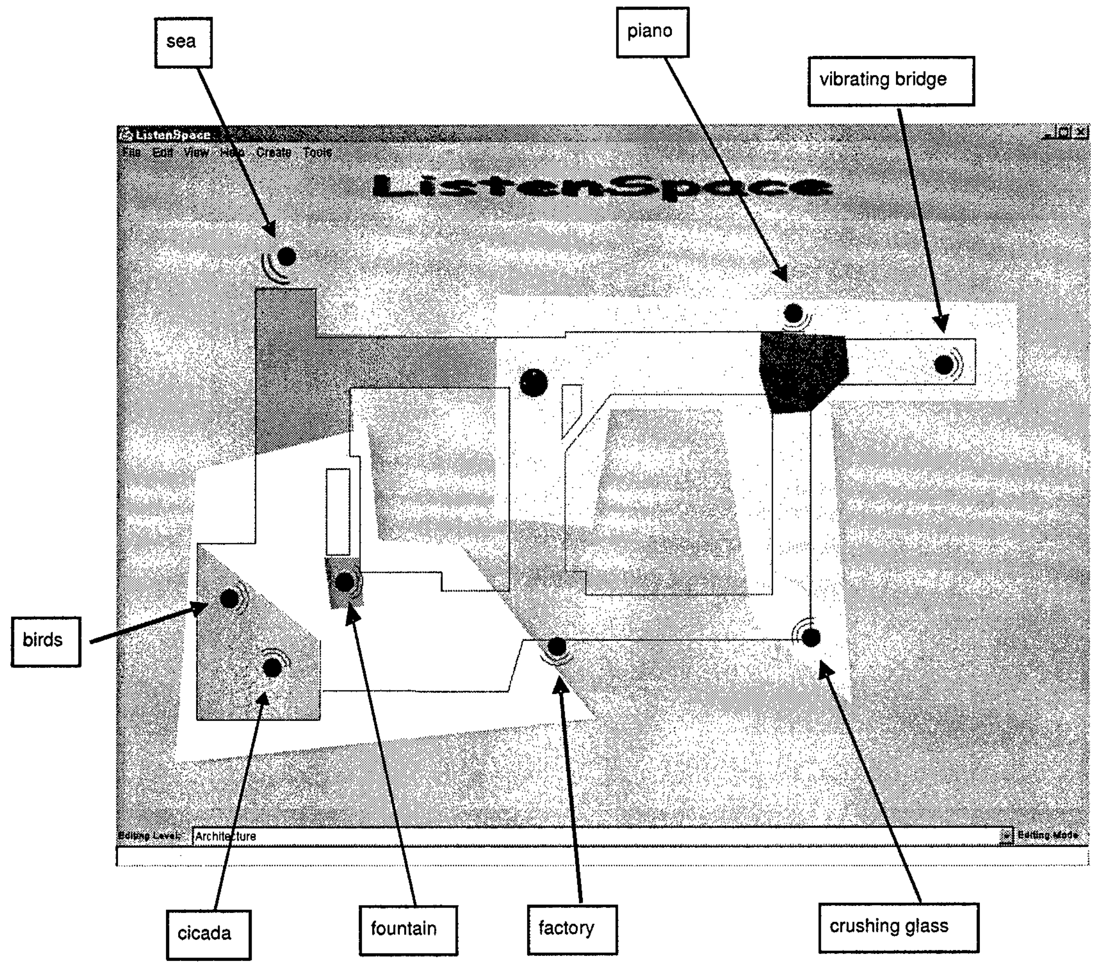

Figure 2. Auditory environment in AVis condition
The sounds are played according to the computed position and distance of the subject with respect to the source when he/she enters an activation area. Large activation areas: ambisonic sounds scenes (4 channels audio format) recorded in a urban environment. Small activation areas: binaurally rendered monophonic sources.

Presence

The two-way ANOVA with condition as a within-subjects factor and with group as between-subjects factor on presence scores indicated a main effect of condition ($F(1,17)=7.3$, $p=0.01$). Presence scores were higher in the AVis condition in both groups of subjects (Table 1). The analysis of variance with condition as a within-subjects factor and with presentation order of conditions as a between-subjects factor indicated only a main effect of condition ($F(1,17)=9.29$, $p<0.01$). However, the interaction between presentation order and condition was marginally significant ($F(1,17)=4.1$, $p=0.06$). Indeed, presence scores increased during the second session only in *Vis first* presentation order. In *AVis first* presentation order, presence scores decreased during the second session (for *Vis first*, Vis=39.6, SD=15.2, AVis=41.7, SD=18.7; for *AVis first*, AVis=41, SD=15, Vis=30.7, SD=14.7). This observation is in agreement with the finding that auditory modality improves the sense of presence, since removing it has the opposite effect.

Cybersickness

The ANOVA with condition as a within-subjects factor and with group as a between-subjects factor on cybersickness scores showed an interaction between the factors group and condition ($F(1,17)=10.6$, $p<0.01$). Cybersickness scores significantly increased in AVis condition in patients group. It is unlikely that these scores represent mainly signs of somatisation since there is no difference between the two groups of subjects in the Vis condition. The analysis of variance with condition as a within-subjects factor and with presentation order of conditions as a between-subjects factor indicated only a main effect of condition ($F(1,17)=6.1$, $p<0.05$).

State anxiety levels

The two groups differed in all measures of state anxiety (Table 2). A three-way analysis of variance with two repeated measures on condition and the two state anxiety scores (before and after the VR session) was performed between the two groups (2 x 2 x 2). The analysis indicated a main effect of group ($F(1,17)=12.9$, $p<0.01$) but there was no interaction between the different factors, suggesting that state anxiety levels before and after the VR session were not different for any of the groups.

Navigation in Vis and Avis condition

No difference between the groups nor between the conditions was found in the two measures taken during navigation (time spent in VR and number of landmarks found). The analysis of variance with condition as a within-subjects fac-

Table 1. Means and *(SD)* of the scores to the different measures related to VR according to the group and the condition.

	Vis condition		AVis condition	
Measure	Control group (n=9)	Patients group (n=10)	Control group (n=9)	Patients group (n=10)
Time in VR (in sec)	474 *(206)*	509 *(194)*	469 *(170)*	428 *(211)*
Landmarks found during navigation (Max=11)	9.7 *(2.9)*	8.6 *(2.9)*	10.4 *(1.1)*	8.9 *(3.8)*
2-choice forced recognition (Max=10)	6.9 *(2.0)*	7.7 *(1.4)*[a]	7.3 *(1.1)*	6.6 *(1.6)*[a]
Correctly localized landmarks (Max=12)	7.3 *(2.6)*[b]	5.0 *(3.3)*[b]	6.9 *(2.8)*	5.1 *(3.3)*
Cybersickness	5.2 *(5.3)*	6 *(7.8)*	4.6 *(6.2)*	18.8 *(14.6)*
Presence	32.4 *(13.1)*	38 *(17.2)*	40 *(14.1)*	42.6 *(19.2)*

[a] *Wilcoxon rank test, t=3, p<0.05*

	Control Group (n=9)				Patient Group (n=10)			
	Vis condition		AVis condition		Vis condition		AVis condition	
Time	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Before the session	23.7	2.7	23.4	2.7	29.6	7.6	33	8.6
At the end of session	22.7	4.2	24.4	5.1	32.4	10.2	37	10.8

Table 2. State anxiety levels at the beginning of and after completing a session

tor and with presentation order of conditions as a between-subjects factor indicated an interaction between presentation order of conditions and condition on time spent in VR ($F(1,17)=11.6$, $p<0.01$). Indeed, time spent in VR always decreased during the second session, but time spent in VR during the first session was much shorter in the case of *AVis first* (for *Vis first*, Vis=573, SD=149 sec, AVis=438 sec, SD=162; for *AVis first*, AVis=462 sec, SD=220, Vis=403 sec, SD=209). Since time spent in VR is a measure of time to find the landmarks and to feel familiarity with the town, this indicates that AVis condition does provide more efficiency in spatial exploration.

Correctly localized landmarks (after navigation)

No difference between the groups nor between the conditions was found. The analysis of variance with condition as a within-subjects factor and with presentation order of conditions as a between-subjects factor indicated an interaction between presentation order and condition ($F(1,17)=12.9$ $p<0.01$). Performance always increased for the second session, but the increase is higher when the first session was in AVis condition (for *Vis first*, Vis=5.1, SD=3.3, AVis=6.5, SD=3.1; for *AVis first*, AVis=5.3, SD=3.3, Vis=7.2, SD=2.7).

Two-choice forced recognition (after navigation)

No difference between the groups or between the conditions was found with either analysis of variance. However, the interaction between group and condition was marginally significant ($F(1,17)=3.04$, $p=0.09$). While normal subjects' performance tended to increase in AVis condition, patients' performance tended to decrease in comparison with performance in Vis condition. No presentation order effect could explain this observation.

DISCUSSION:

In the present experiment, we compared navigation in a visual VE with navigation in an auditory-visual VE in two samples of subjects. As expected, presence scores were significantly higher in AVis condition. Presentation order of conditions was not at stake in this result, since the order of sessions was counterbalanced across subjects. However, analysis of the effect of presentation order pointed to a beneficial effect of auditory modality: time spent in VR to find the landmarks was shorter in *AVis first* order, the increase of number of correctly localized landmarks at the end of the second session was higher in *AVis first* order.

The two groups behaved differently with regard to the two conditions. While normal subjects did not exhibit more signs of cybersickness in AVis condition, the level of discomfort of anxious patients was significantly higher in this condition. In addition, anxious patients had poorer performances at a visual recognition test in AVis condition. These results are in agreement with the hypothesis of a multisensory integration deficit in this population. The attempt to continuously adjust the relative weighting of auditory, visual, and idiothetic information may have caused an attention load which prevented allocation of attention resources to the VE.

In the setup we used, the imperfect mapping between the motor outflow and the multiple sen-

sory feedbacks (movement of the head and its visual and auditory feedbacks) can be the cause of the increased symptoms of cybersickness in the AVis condition. It exhibited the significance of mastering the delay between sound and images updating so that no supplementary conflict is introduced.

The present experiment confirmed the importance of 3D audio for the construction of a virtual space. Control subjects said that the experience was more compelling when 3D auditory information was delivered during the virtual navigation, while several patients reported that the two worlds (auditory and visual) could not fulfill a sense of realism when presented together. The visual world we were using was composed of rich textures attempting to model a realistic urban environment. The auditory world was mainly composed of ambisonic sounds recorded in a city, which corresponded to highly textured sounds. In spite of the equivalent richness of both channels, anxious patients tended to perceive them separately. If this mode of perception can be linked to a sensory overload originating from their high sensitivity to multisensory information, a question remains about the sensation of coherence at the semantic level between the visual scene and the auditory scene[14]. Focusing on this issue, we are currently conducting an experiment in which the visual environment is purely symbolic. Assuming that patients would not have a dual mode of perception in a symbolic VE, it might be possible to unravel primitives that might be sufficient to elicit emotional reactions, presence and rehabilitation.

Computationally it is currently easier to achieve high resolution and realism in an auditory VE than in a visual VE. In an attempt to address this issue, we conducted a trial on 4 patients who were asked to navigate blindfolded in an auditory only VE and were surprised to observe that time of immersion tremendously increased (patients were willing to explore the VE as long as possible) while navigation was efficient (all auditory landmarks were found). Furthermore, realism was judged as very high and patients produced an accurate graphic reproduction of layout of auditory landmarks. This condition seems therefore promising for research in therapeutic methods in which VR should not limit its aim to copy reality but should invent new ways to engage the immerged subject. Applied research with virtual sound has been performed in the last decade in order to allow the visually impaired to develop more accurate and extensive knowledge of spatial layout[15,16]. Hopefully this kind of VR will provide therapeutic benefit for all kinds of populations.

Acknowledgements

We are grateful to Olivier Delerue for providing ListenSpace, the software which enabled the authoring of soundscapes, and Guillaume Vandernoot for his work on HRTFs measurements. We thank Ludivine Sarlat, Feryel Znaïdi, Antoine Pelissolo and Johana Santos for their help with the patients. This study was supported by the French program "Cognition et traitement de l'information" from the CNRS, grant CTI 01-54.

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The Importance of Significant Information in Presence and Stress Within a Virtual Reality Experience

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ABSTRACT: *In this paper, a pilot study on the relationship between significant information, presence, and stress in virtual environments is presented. The experiment shown in this work was performed with a Medical Emergency Training Simulator based on virtual reality, and was conducted with two sets of subjects: critical care specialists and people without experience in medicine, trained to properly act with the concrete clinical problem being simulated. During the experiment, the Galvanic Skin Response (GSR) of the subjects was recorded, and presence and stress questionnaires were completed by the subjects. This study found that results from stress and presence measurements show an evident correlation, making apparent a close relationship between both variables. Our results also show the importance of significant information when a high degree of presence or stress is needed in a VR Training Simulator.*

1. INTRODUCTION:

Intensive care specialists are needed to work in critical situations under high levels of stress. This kind of strain has a great importance in the emotional state of the medical specialist, and so, they have to be prepared to work in such adverse conditions. Hence, training simulators in this field must not only provide an environment to teach cognitive skills necessary for patient assessment, they also need to elicit that emotional state in the subject. In order to achieve those capabilities, training simulators can use Virtual Reality (VR) technology, which may induce more intense feelings in the trainee.

In this context, presence, as a subjective sense, has been argued to be a very important factor for human performance in general VR systems[1]. Furthermore, studies on this subject have found a relationship between the level of presence and stress[2, 3]. If the recreated virtual environment presents a stressful situation, a high degree of presence will yield a high level of stress[4, 5]. So, in this kind of environment, stress measurements could be used as an indirect presence indicator. But we can go further by hypothesizing that eliciting stress in the subjects exposed to a virtual experience will help to achieve higher degrees of presence. This last hypothesis is discussed in this paper.

In addition, in this work we study how significant information presented in the virtual world concerns the elicited stress and presence. The same stimuli can provoke very different reactions depending on the significance of the presented information. For a medical specialist with real experience in critical care, a virtual patient evokes feelings and memories that can increase both stress and presence. However, subjects without that real experience tend to respond in a different way, even with the same environment and stimuli.

This paper is organized as follows: Section 2 describes methodology and tools used in the experiment. Section 3 presents the obtained results and discusses them. Finally, in Section 4 these results are discussed, and in Section 5 conclusions obtained from this work are presented, as well as future research goals.

2. METHOD AND TOOLS:

2.1 Training Simulator Description.

The experiment discussed in this work was performed with UVIMO, a Medical Emergency Training Simulator based on VR and developed for this research. UVIMO provides a virtual environment of a stressful emergency situation with realistic 3D graphics, including a virtual patient lying down on the floor, medical equipment placed around him, and the complete recreation of a typical environment in which the action occurs.

Sense8 WorldToolKit has been used as the simulation engine. A Virtual Research V8 Head Mounting Display (HMD) was used as the visualization device, and an Ascension Technologies Flock of Birds was used to track head movements.

The virtual patient was presenting an acute myocardial infarction, with a clinical history of ischemic cardiac myopathy and diabetes. He was modeled by means of an Expert System, which contained the rules that allow the patient to respond to the treatment and to progress by himself. The subjects were asked to treat him within UVIMO in two different scenarios: a quiet living room, and a noisy street. Figures 1 and 2 show a snapshot of these two virtual places. The goal of this choice was to provide a non-stressful environment, and a stressful one, independently of the action to be carried out within them.

Figure 1. Quiet virtual environment

Figure 2. Noisy street virtual environment

Interaction was managed by an assistant, who played the role of a nurse, receiving orders from the subject under test. The subject could ask the assistant for any information not directly available in the virtual world, like arterial pressure, temperature, etc. In addition, the assistant could apply any treatment the subject asks for.

2.2 Participants.

The experiments were done with a total of twelve participants, ranging in age between 26 and 47, who volunteered for this study, made up of 5 males and 7 females. There were two sets of subjects: critical care specialists (aged between 31 and 47; 3 males, 3 females), and people with similar academic degrees in other fields of science, and without experience in medicine (aged between 26 and 33; 2 males, 4 females).

The former, called Group A from now on, reported less experience in using computer than the latter one, called Group B from now on.

Group B was trained in a one hour tutorial about how to treat this specific clinical problem, including the use of available drugs and medical equipment, as well as their effects in the case of inappropriate application.

2.3 Measurements.

Two main types of measurements were taken: questionnaires to estimate the level of stress and the degree of achieved presence, and physiological measurements of Galvanic Skin

Response (GSR). In addition, significant postural movements and attitude changes were annotated.

2.3.1 Questionnaires.

A presence questionnaire by Slater[6], translated into Spanish, was used to estimate the degree of presence achieved in the virtual experience. The original questionnaire consisted of five questions, the answers to which were rated from 1 to 7. A sixth question concerning the virtual patient was added. The Presence Index (PI) was taken as the number of questions rated as 6 or 7, normalized, and expressed as a percentage:

In order to estimate the induced stress, the Stress Arousal Checklist (SACL) [7] was used. The SACL is a state measurement of stress and arousal. In other words, the SACL can measure how stressed or aroused an individual is at any particular time. It does not measure a person's tendency to be stressed or aroused. This test gives a number from 0 to 18 as stress index. A normalized index, expressed in percentage, is

$$PI = \frac{\sum_{i=1}^{6} Q_i}{6} * 100; \quad Q_i \equiv \begin{cases} 1 & \text{if rate(i - th question)} > 5 \\ 0 & \text{otherwise} \end{cases}$$

$$SI = \frac{\text{SACL stress index}}{18} * 100$$

2.3.2 Physiology.

Galvanic Skin Response (GSR) of the subjects was recorded by a skin conductance module Coulbourn V71-23, using DC coupling, a sensitivity of 100 mV/μS and two 8mm AgCl/Ag disposable electrodes placed on the middle and index fingertips of the left hand (all the subjects were right handed). The analog signal was acquired by a National Instruments NI-6036E acquisition card and a software tool developed for this experiment.

2.3.3 Behavioral annotations.

In addition to the above measurements, all significant postural movements, such as pointing or trying to touch virtual objects, were noted. The subjects' attitude to the assistant was also annotated. The idea behind this is that involuntary movements or attitude changes may be signs of high presence.

2.4 The experiment.

Before starting each session, the subjects were informed about the methodology of the experiment, and the measurements to be taken. Each session lasted for about 60 minutes, consisting of three different trials, and was carried out with the following scheduling:
-Estimation of stress previous to the experience
-Control trial (first trial)
-Estimation of stress in the control trial
-Virtual experience in the quiet environment (second trial)
-Estimation of stress and presence in the second trial
-Virtual experience in the noisy environment (third trial)
-Estimation of stress and presence in the third trial

GSR was measured during the three trials, including a period of 90 seconds before the beginning of each of them, to obtain the baseline. During this time, the subject was asked to be as relaxed as possible.

2.4.1 Control trial

For the first trial a task was chosen which did not require specific knowledge or capabilities related to medicine. Subjects were asked to play the popular game 'Simon', in which they had to reproduce an increasing random sequence of colours and sounds. This trial lasted for 4 minutes. When the subject failed the sequence, they had to start from the beginning again.

2.4.2 Virtual experience in the quiet environment

In the second trial, subjects were exposed to UVIMO in a quiet living room, as commented below (see Figure 1). However, it was not a completely silent environment. Beeps from medical equipment could be heard, as well as verbal communication between subject and assistant. This trial had a duration of 3 minutes, independent of the state of the virtual patient.

2.4.3 Virtual experience in the noisy environment

The third trial took place in a noisy street. Subjects were exposed again to UVIMO in that environment (see Figure 2). This trial had a duration of 3 minutes, independent of the state of the virtual patient. In this case, the noise acted as a stressful element, and made communication between the subject and the assistant more difficult.

3. RESULTS:

3.1 Questionnaires

The SACL, used to provide a stress index (SI), was administered four times to each subject: one before the beginning of the session (SI_0), as a baseline measurement, and one immediately after each trial. Let the increment of i-th trial stress index (SI_i) relative to SI_0 be defined as:

$$\Delta SI_i = SI_i - SI_0$$

Figure 3 shows ΔSI_i for both groups of subjects. It is easily seen that all trials produce a positive increment of stress. The control trial increases the SI in a small amount, 10% for specialists

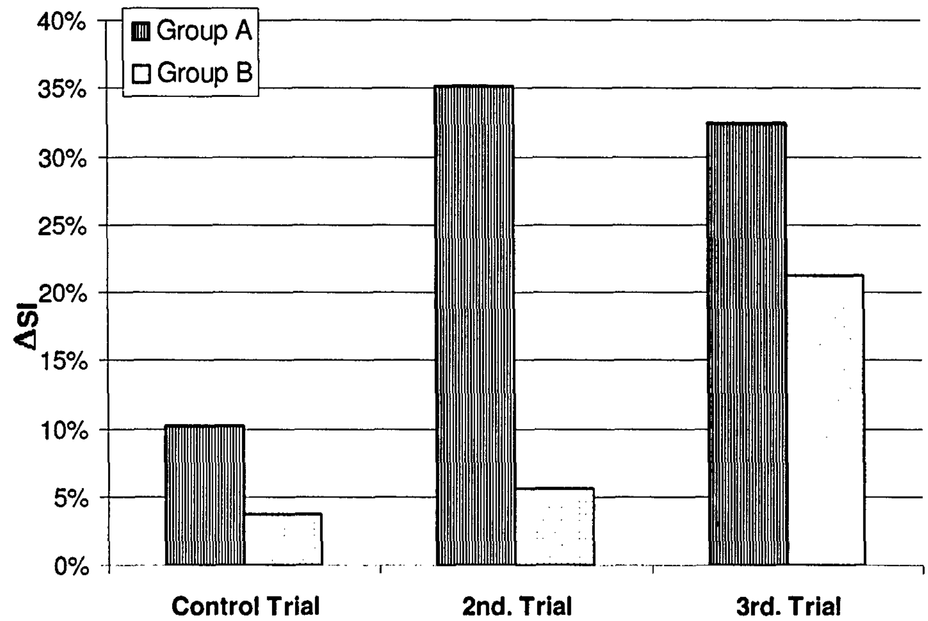

Figure 3. Increment of stress index

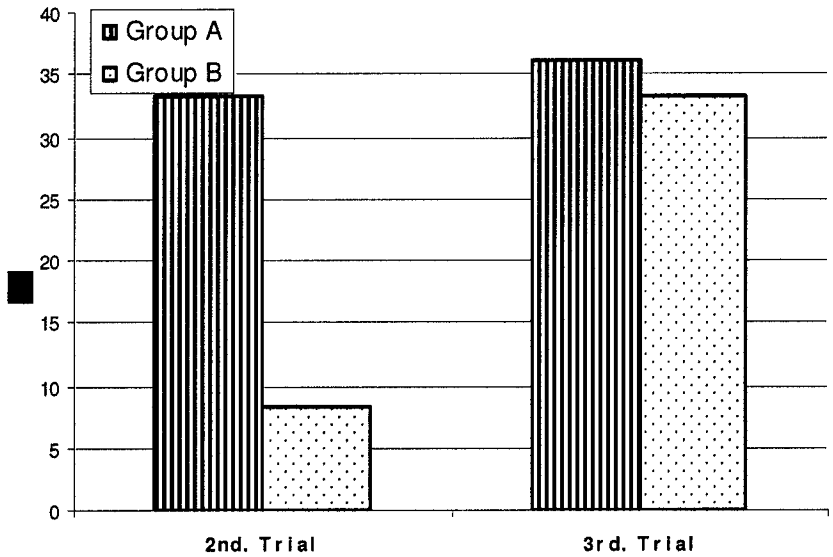

Figure 4. Presence index

and 4% for non-specialists. It is important to take into account that subjects from Group A reported significantly less use of computers in their work than subjects from Group B, which could explain this difference.

Similarly, the stressful virtual environment elicits a high increase of SI, approximately 30% in Group A and 20% in Group B. The obvious difference between the two groups is in the second trial, where subjects were exposed to UVIMO within a quiet virtual environment. Subjects without real experience in critical care do not show much more increment of SI than in the control trial. However, subjects with that experience present increments of SI that are similar to those in the third trial.

These results suggest that for Group B, the content of virtual experience has not contributed to increasing SI. However the noise presented in the third trial acted as a stressful element, which may justify the high ΔSI_3. However, for Group A, the content seems to be the main stressor, as the clinical problem was the same in the second and third trials. For Group A, the differing trial is clearly the first one, because ΔSI_1 is much lower than ΔSI_2 and ΔSI_3.

Figure 4 shows the obtained presence index (PI) for both virtual experiences and groups. It is clear that Group A presents similar PI in both experiences, while Group B reports very different PI in both trials. The first trial elicited a very low level of presence in Group B, while the second trial provokes a similar level of presence in both groups.

The correlation between our measurements of stress and presence is evident. High stress levels and high presence indicators are clearly associated. On the other hand, a low degree of presence is also associated to low stress measures.

3.2 Galvanic Skin Response

GSR was recorded for all subjects so as to obtain an objective estimator of stress. A baseline period of 90 seconds was recorded before starting with each trial. The average value of GSR over this period has been taken as GSR baseline, and this value is used to express GSR in a relative way, skipping the great inter-individual variability of raw GSR. So, we use GSR* defined as Galvanic Skin Response.

$$\Delta GSR = \frac{(GSR - GSR\ Baseline)}{GSR\ Baseline}$$

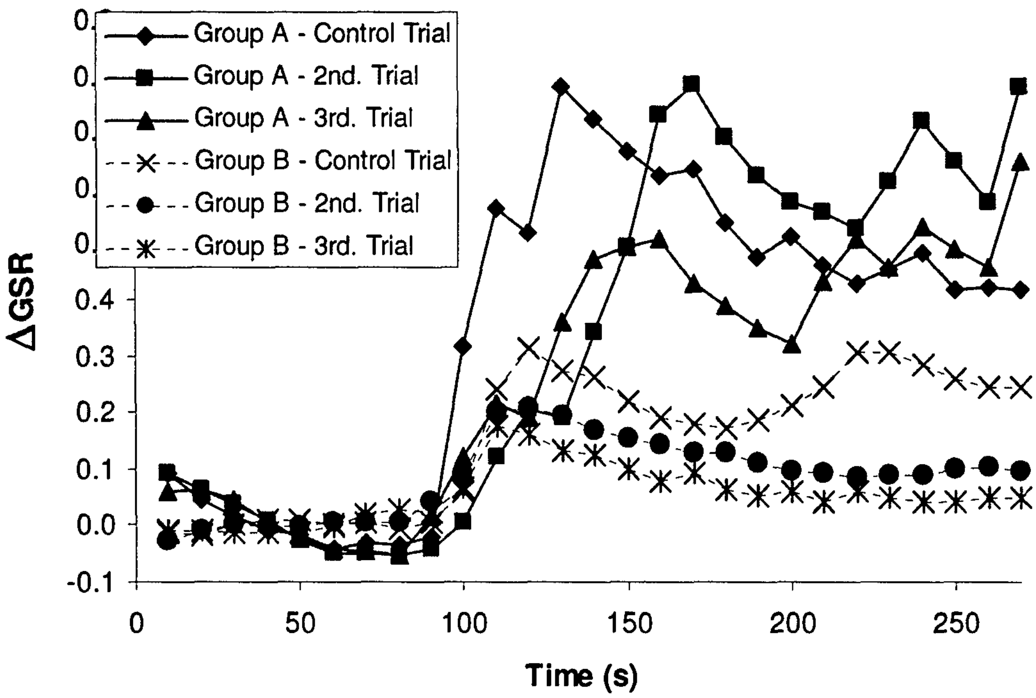

Figure 5. Galvanic Skin Response

Figure 5 shows the tonic level of ΔGSR averaged for each group of subjects, every ten seconds. In continuous lines, the three trials for Group A are represented, and in dashed lines, the three trials for Group B.

The first remarkable finding is the sheer rise after the first ninety seconds, just at the beginning of each trial. This rise is clear in the three trials and the two groups of subjects, but in Group A it is noticeably larger. It is obvious that GSR, as an arousal indicator, increases when each trial begins. The differences between Groups A and B can not be explained by the special significance that the simulated situation has for Group A subjects, because that difference also appears in the control trial, which has no relation with medical activities. As commented below, Group A reported less experience with computers than Group B. This could be the reason for this higher GSR during the trials.

In Group B, a slight decrease of GSR tonic level can be seen in Trials 2 and 3, while not in the control trial. On the other hand, Group A presents the opposite effect. But the high variability of these signals undermines this phenomenon in itself. Larger groups are necessary in order to confirm or discard this effect.

Anyway, it is clear that average tonic levels of GSR are not good estimators of stress or of presence. In this case, tonic level of GSR can only be used as a generic arousal index. Although it can sometimes be confused with an erroneous stress or presence index, control trials confirm that this is not the case.

3.3 Postural movements

During Trials 2 and 3, all significant movements of subjects were annotated. Although it is difficult to quantify this kind of behavior, it was clear that Group A subjects made more significant movements than Group B while exposed to the simulator. They include pointing to virtual objects, head movements, and a sharper attitude with the assistant when the virtual patient state was more complicated.

Group B subjects, however, were much more static during the experience, especially during the second trial. This leads to suggest that presence was greater for Group A than for Group B.

4. DISCUSSION

Subjects from Group A, specialists in critical care, and with first hand experience similar to this virtual experience, report a high degree of presence in both environments. However, subjects from Group B, without such experience, have a high degree of presence only in the stressful environment. Hence, the information available in the virtual world has a different meaning for the former than for the latter, even when all of them have enough knowledge to act within the virtual world in a proper way.

We hypothesize that relationships between the virtual world and experience in the real world could play a very important role in eliciting some emotional engagement, which leads to increased presence.

In addition, a strong correlation has been found between increment of stress and presence. It seems to be clear that both variables are closely related. In fact, it has been argued that presence could be a stress generator if the virtual environment is stressful[4,5], which is a very reasonable assumption. However, Group B presents very different degrees of presence in both quiet and noisy environments, and there is no good reason for this phenomenon if we only take into account the differences between the two environments. It can be argued that traffic noise makes the second environment more realistic, as it presents multimodal stimuli, but the first one also has visual and auditory stimuli, and the interaction with the assistant is based on a conversational interchange. In addition, sound is coherent with the virtual world in both cases.

On the other hand, it can also be argued that noise and consequent difficulty in communicating with the assistant is a clear stressor, and so, the increment of stress in Group B within the noisy environment could be explained by the noise itself. Then, the increment of presence in this last case could be caused by the stress, and not vice versa.

Postural movements seem to be an interesting indicator of presence, as pointed out by other authors[9,10]. Trials in which a high index of presence was measured correspond to those in which subjects made more involuntary movements. However, it is necessary to define a procedure to quantify this behavior in order to obtain a reliable index of presence.

Regarding objective measurements based on psychophysiological signals, the use of averaged GSR to assess the emotional state can be found in the literature[10,11]. In this paper, the relationship between averaged GSR, stress, and presence has been explored. It has been shown that averaged GSR can not be used as a stress nor presence index. Here, it seems that GSR is just a generic arousal index. The relationship between this arousal and stress or presence is not clear. This has been proven by means of a control trial.

5. CONCLUSIONS AND FUTURE WORK

In this paper, a pilot study on the relationship between significant information, presence and stress has been presented. Our results suggest the importance of significant information when a high degree of presence or stress is needed in a VR Training Simulator.
Our results suggest a strong and close relationship between increment of stress and presence, because each one could be cause and consequence of the other. This is an interesting finding because we can include some stressors in VR simulators in order to improve their presence elicitation. However this must be the objective of further research because, as suggested in Mosbruger[12], some kinds of stress can provoke frustration and decrease the sense of presence.

Experience in the use of computers could be an important variable that has not been controlled enough in this experiment. Further research should treat this issue very carefully. In addition, stress sources must be better isolated in order to ensure their apparent role in the measured presence. Moreover, larger groups should be considered. The work presented here is just a pilot experiment, and all these results should be considered cautiously.

ACKNOWLEDGMENTS

This research has been partially supported by the Spanish Ministry of Science and Technology, and ERDF funds (Project TIC2002-04348-C02-01). The authors also wish to thank the professionals from the service of anaesthesiology of Hospital Clínico San Cecilio, in Granada, for their invaluable collaboration as subjects under test.

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Effect of performance demands and constraints within virtual environments

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Abstract: *In recent years, clinical studies have begun to demonstrate the effectiveness of virtual reality (VR) as an intervention tool in rehabilitation. There are, however, a number of important issues that must be addressed in order to determine how widely VR-based intervention should be applied, and the ways in which specific patient populations can benefit from its unique attributes. One of the unresolved issues relates to how the characteristics of a given virtual environment affect a user's performance and therapeutic goals. The objective of this study was to compare the sense of presence, performance and perceived exertion experienced by users when they engaged in two games performed within video-projected virtual environments that differed in their level of structure and spontaneity. VividGroup's Gesture Xtreme (GX) VR, and the rehabilitation-oriented application of GX marketed as IREX (Interactive Rehabilitation and Exercise) were used to deliver the virtual environments. Thirty healthy male and female participants, aged 21 to 35 years, experienced the same two virtual games on both platforms. A mixed design, within and between subjects ANOVA was used to examine the effect of movement constraint and gender as well as the interaction between these variables on the sense of presence, performance and perceived exertion. No main effect or interaction effect was found for the sense of presence, assessed using the Presence Questionnaire (PQ), although significant differences were found for several of the PQ sub-scales. A main effect was found for perceived exertion for both games, however in the opposite direction. We conclude that it is possible to provide users with a satisfactory level of presence and enjoyment using both structured and non-structured paradigms. However, user characteristics such as gender, as well as the therapeutic objectives, should be taken into account in the selection of a suitable application.*

INTRODUCTION:

In recent years, clinical studies have begun to demonstrate the effectiveness of virtual reality (VR) as an intervention tool in rehabilitation. Among its advantages is the opportunity for experiential, active learning which motivates the participant[1-2]. VR also offers the capacity to individualize treatment needs, while providing increased standardization of assessment and retraining protocols. Virtual environments can also provide repeated learning trials and offer the capacity to gradually increase the complexity of tasks while decreasing the support/feedback provided by the therapist[3].

METHODS:

Participants

Thirty participants (14 men and 16 women) aged 21-35 years (mean age 25.4 ± 3), all university students, volunteered to participate in the study.

VR Platforms

The non-structured application was applied using VividGroup's Gesture Xtreme (GX) VR system (www.vividgroup.com), a projected video-capture VR platform originally developed for entertainment purposes that has been adapted for use in rehabilitation[10]. This system has been

recently used in rehabilitation for the treatment of motor and cognitive impairments[7-8, 10-11]. Participants stand or sit in a demarcated area viewing a large monitor that displays games such as touching virtual balls, as shown in the left panel of Figure 1. A single camera vision-based tracking system captures and converts the user's movements for processing: the user's live, on-screen video image corresponds in real time to his movements. The users can interact with graphic objects as depicted in this environment. No additional equipment needs to be worn by participants and the interaction with VE can be via any part of body, which allows the user to respond in a relatively unstructured and spontaneous manner.

The structured application was applied using the IREX platform *Interactive Rehabilitation and Exercise (IREX),* a rehabilitation-oriented application of GX. Since it was developed to give the option to train a specific movement (such as shoulder abduction, in order to increase the range of motion of a specific joint or to increase the endurance) prior to the VR experience, a virtual model demonstrates the desired movement and again during the virtual experience (see the right panel of Figure 1). Once the user is familiar with the required movement, he is ready to engage with the VE. During the experience a graph comparing the desired movement to actual performance is located at the bottom of the screen in order to encourage the user to perform the desired movement. Since interaction should be only with the "affected" arm, the user wears a red glove on one hand and the movements are performed in a highly structured manner.

Virtual Environments

Two of the virtual environments (games) which are run on the GX and IREX VR platform, and have been described in detail elsewhere[10], were used:

(1) Birds & Balls - wherein the user sees himself standing in a pastoral setting where balls of different colors fly towards the user. Depending on the intensity of contact by any part of the user's body, the balls will either "burst" or "transform" into doves and fly away. Performance was rated by the mean response time (RT) of touching the balls for the GX platform and percent of success for the IREX application.

(2) Soccer - wherein the user sees a video reflection himself as the goalkeeper in a soccer game. Soccer balls are shot at him, and his task is to hit them in order to prevent them from entering the goal area. Performance was rated by the percent success of repelling the balls for both applications. For these games, the third minute (out of a total of 4 minutes) of each VR experience was analyzed, since it should reflect the participant's best performance (after participants had practiced but prior to the onset of fatigue).

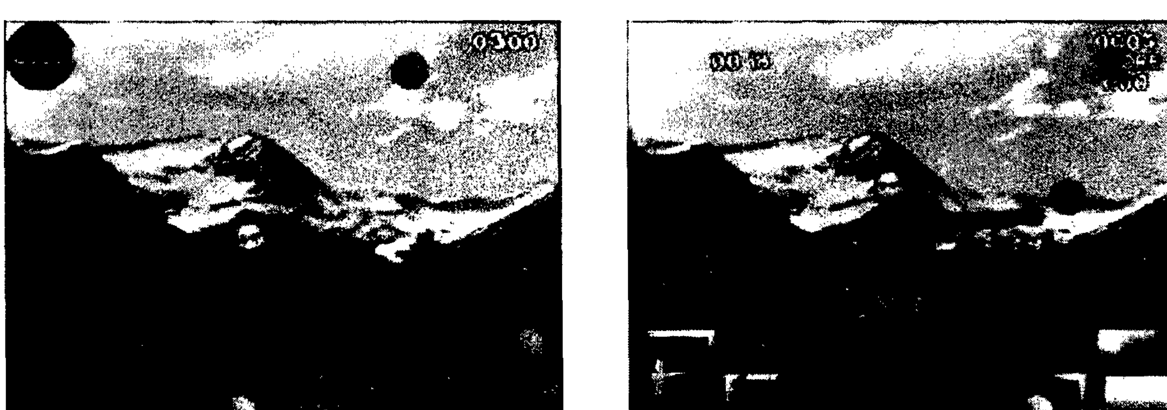

Figure 1: The Birds & Balls environments as used within the non-structured (left) and structured (right) applications.

Outcome Measures

Presence Questionnaire (PQ) (translated from Witmer & Singer, 1998)[12] was used to assess presence. It is composed of 19 questions in which participants use a 7-point scale to rate various experiences within the VE; the maximum total score is 133 points. The items assessed different aspects of presence: involvement/control, natural, interface quality and resolution.

Scenario Presence Questionnaire (SPQ), (based, in part, on a translated version of Witmer and Singer's Presence Questionnaire[12]) was administered after every environment. The six items assessed the participant's (1) feeling of enjoyment, (2) sense of being in the environment, (3) success, (4) control, (5) perception of the environment as being realistic and (6) whether the feedback from the computer was understandable. Responses to all questions were rated on a scale of 1-5. These questions were combined to give a global response to the experience for a maximum score of 30. This 6-item questionnaire was formulated as an abbreviated alternative to the longer Presence Questionnaire.

Borg's Scale of Perceived Exertion[13] was used to assess how much physical effort the participant's perceived that they expended during each VR experience. This is a 20-point scale that participants rated from 6 (no exertion at all) to 20 (maximal exertion).

PROCEDURE:

Participants signed an informed consent and then filled in a demographic questionnaire. They experienced both of the games using the first application while after each game they filled out the SPQ and rated their perceived exertion on Borg's scale for the specific scenario. After completing the two environments for a given VR application, participants completed the Presence Questionnaire. The same procedure was then done for the second platform while the order of the platforms was counterbalanced.

DATA ANALYSIS:

A mixed design, within and between subjects ANOVA was used in order to examine the effect of the type of VR application (delivered via GX versus IREX) and the user characteristics (i.e. gender) as well as the interaction between these variables on the sense of presence, performance and perceived exertion.

RESULTS:

As a first step for analysis we examined whether the order of experiencing the VR platforms influenced the results. There were no significant differences due to the order in which the VR applications were experienced by participants for any of the outcome measures.

	Non-structured movement			Structured movement		
	male N=14	female N=16	total population N=30	male N=14	female N=16	total population N=30
PQ total (19-133)	93.3 ± 15	95.6 ± 11.4	94.6 ± 18.4	100.3 ± 17.3	92.5 ± 19	96.2 ± 18.4
Involvement/ control (11-77)	56.7 ± 9.1	60.2 ± 7.3	58.6 ± 8.2	59.6 ±10.1	53.8 ± 11.07	56.5 ± 10.8
natural (3-21)	12.4 ± 3.5	14.5 ± 2.6	13.5 ± 3.2	13.7 ± 3.04	13 ± 4.2	13.3 ± 3.6
resolution (2-14)	7.8 ± 2.8	8.8 ± 3.1	8.4 ± 3	9 ± 3	8.7 ± 3.8	8.8 ± 3.4
quality (3-21)	16.3 ± 3.7	12 ± 3.5	14 ± 4.2	18 ± 3.2	17.1 ± 3.1	17.4 ± 3.1
SPQ (6-30)						
Birds and Balls	24.1 ±2	26.2 ± 2.5	25.2 ± 2.5	19.2 ± 3.8	19 ± 4.4	19 ± 4.1
Soccer	21.3 ± 3.4	21.7 ± 5	21.5 ± 4.2	21.7 ± 4.5	24 ±4.6	23 ± 46

Table: Results from the Presence Questionnaire (PQ) and the Scenario Presence Questionnaire (SPQ) comparing participant responses when using virtual environments in non-structured and structured paradigms.

The Sense of Presence

No main effect or interaction effect was found for the total PQ, however for three of the four subscales of the PQ interaction effects were found: For the Involvement/Control PQ subscale an interaction effect for application and gender was found ($F(28)=6.7$, $p=.015$), for the Resolution subscale an interaction effect for application and gender was found ($F(28)=4.3$, $p=.047$) and for the Interface Quality subscale, a main effect for type of application ($F(28)=15.3$, $p=.001$) and an interaction effect for application and gender was found ($F(28)=4.2$, $p=.048$). The scores of the total PQ and it's subscales for both the non-structured and structured movement applications appear in the table.

Scenario Presence Questionnaire

Birds and Balls - a main effect for the type of application was found ($F(28)=45.1$, $p=.000$). Using the non-structured application, the participants felt a significant higher sense of enjoyment, control, realism versus the structured mode while playing Birds and Balls (see Table).

Soccer - No main effect or interaction effect was found for playing soccer using a non-structured versus a structured application (see table).

Performance

Due to technical difficulties and different outcome measures for the Birds & Balls game on the two platforms, comparison between the movement constraints within the VE was not possible. Therefore, only the percent of success playing Soccer was compared. A significant main effect for the type of application was found ($F(28)=159.7$, $p<.0001$). Using the non-structured movement the percent of success of stopping the balls of going into the goal was 49.8 ± 9.7 while the percent of success for using a structured movement was 92.4 ± 15.8. This difference was found to be significant ($t(29)=12.6$, $p<.0001$). Performance during soccer for the structured application may have been higher since balls are presented close to the user's hand; they are not randomly distributed as for the non-structured application.

Perceived Exertion (Borg Scale)

A main effect for the type of application was found for both games (Birds and Balls ($F(28)=12.05$, $p=.002$), Soccer, ($F(28)=16.02$, $p=.000$)) however in the opposite direction, as shown in Figure 2.

While playing soccer using a structured application, a moderate positive correlation was found

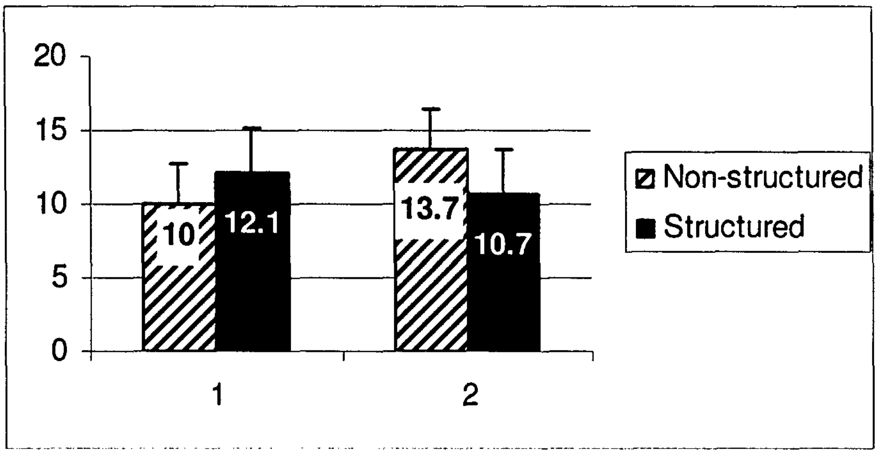

Figure 2: Comparison between the perceived exertion when using virtual environments in non-structured and structured paradigms.

between the percent of success and the Scenario Presence Questionnaire ($r = .46$, $p<.05$). In other words, the more the participant succeeded in blocking the soccer balls from entering the goal crease, the more he felt enjoyment, control, etc. In addition, a moderate negative correlation was found between the perceived exertion while playing soccer with a structured application and Scenario Presence Questionnaire ($r = -.38$, $p<.05$) (i.e. the more the participant felt enjoyment, control, the less he perceived exertion while playing soccer).

CONCLUSIONS:

These results support the use of either structured or non-structured movement in therapy. Selection of one or the other should depend upon the therapeutic goals for remediation of neuromuscular deficit. Both movement options used in this study, structured and non-structured, enhance the therapist's repertoire of VR intervention tools to maximize rehabilitation. In addition, the results support the influence of user characteristics such as gender.

It is important to note that, in addition to the results presented here, our impression is that there are many subtle and not-so-subtle differences between the structured and the non-structured movement paradigms which may be relevant for therapy. For example, motor planning capabilities may only be evident when movement demands become more complex (i.e. when using both the hands as well as other parts of the body). This is possible only via the non-structured applications (GX Platform) because it encourages the user to react to simultaneous, randomly distributed stimuli.

We have also noted that a more non-structured movement paradigm enables a therapist to identify underlying motor problems that would not be observed with conventional structured treatment and assessment. For example, the paretic limb of a patient who has had a stroke may be capable of movement when activated in isolation but become clumsy or slow when activated with the rest of the body. These and other issues will be examined in future studies.

Now that a variety of virtual environments are available for use in rehabilitation it is imperative to identify how variations in performance demands and constraints affect their suitability for intervention of specific cognitive and motor deficits. This study is one of the first to address the effect of one important therapeutic parameter ¾ spontaneity versus rigidity on performance ¾ has on participant responses and behaviors. The next step will be to examine these effects in patients with motor and/or cognitive deficits. It is possible to provide users with a satisfactory level of presence and enjoyment using both structured and non-structured movements. The user characteristics such as gender must be taken into account since it <u>and</u> movement constraints influence the user's sense of presence. Further study is needed to explore interactions between performance and presence and between perceived exertion and performance.

ACKNOWLEDGEMENTS:

Financial support from the Caesarea-Rothschild Institute at the University of Haifa, the Israeli Ministry of Health and the Koniver Foundation is greatly appreciated. Students in the Dept. of Occupational Therapy at the Haifa University participated in the data collection. Adaptations to the virtual environments were programmed by Meir Shachar and Yuval Naveh.

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Virtual Reality in Mental Health: the VEPSY UPDATED Project

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Abstract: *The possible impact of VR on mental health has the potential to be even higher than what is currently offered by the new communication technologies such as the Internet. In fact, VR is simultaneously a technology, a communication interface, and an experience: a communication interface based on interactive 3D visualization, able to collect and integrate different inputs and data sets in a single life-like experience. However, significant efforts are still required to move VR into routine clinical use: the "best" evidence in evaluating the efficacy of a therapy/approach is the results of randomized, controlled clinical trials. However, if we check the available literature, the number of published trials is still scarce.*

The main objective of the European funded VEPSY project was to demonstrate the technical and clinical viability of using Virtual Reality Therapy (VRT) in clinical psychology. Using VRT, it is possible to offer both exposure therapy, the most effective form of behavioral therapy for many conditions, and to integrate it with other traditional psychotherapy methods in order to improve their effectiveness. The project was developed and validated in different controlled clinical trials a well as different virtual environments to be used in clinical assessment and treatment of: social phobia, panic disorders, male sexual disorders, obesity and eating disorders. The controlled trials involved a total of ***388 patients****, the largest-ever controlled study in VR therapy.*

1. INTRODUCTION

The possible impact of Virtual Reality (VR) on mental health could be even higher than the one offered by the new communication technologies like Internet. In fact, VR is at the same time a technology, a communication interface and an experience[1]: a communication interface based on interactive 3D visualization, able to collect and integrate different inputs and data sets in single real-life-like experiences.

Previous work has shown that even relatively unsophisticated Virtual Reality tools can prove a valuable tool in psycho-neurological assessment and rehabilitation[2,3]. To date, however, the use of VR-technologies *has been limited to single locations* – typically hospital or rehabilitation

centers. In theory, new multi-user VR technologies combined with rapid increases in Internet bandwidth and performance, as well as steep reductions in the cost of hardware and software, making it possible to bring distributed VR environments directly to clients' homes – thereby offering improved access for users who are inadequately served by current services. In order to achieve this goal, it will first be necessary to overcome a number of clinical, ergonomic, technological, and organizational challenges. The main contribution of the European Community funded "Telemedicine and Portable Virtual Environment for Clinical Psychology" – VEPSY UPDATED – research project to innovation in this area is to design, test, and validate solutions to these challenges[4].

The main objective of the project is to prove the technical and clinical viability of using Virtual Reality Therapy (VRT) in clinical psychology. In particular, the project designed and developed 4 clinical modules and their associated clinical protocols, to be used for the assessment and treatment of the following disorders:

- panic disorder and agoraphobia
- male impotence and premature ejaculation
- obesity, bulimia and binge-eating disorders
- social phobia

In fact, VR offers a blend of attractive attributes for the psychologists. The most basic of these is its ability to create a 3D simulation of reality that can be explored by patients. VR can be considered a special, sheltered setting where patients can start to explore and act without feeling threatened. In this sense, the virtual experience is an "empowering environment" that therapy provides for patients[2]. As noted by Botella and colleagues[5], nothing the patients fear can "really" happen to them in VR. With such assurance, they can freely explore, experiment, feel, live, experience feelings and/or thoughts. VR thus becomes a very useful intermediate step between the therapist and the real world.

This paper describes the clinical and technical rationale behind the clinical applications developed by the project. Specifically the paper focuses its analysis on the possible role of VR in clinical psychology and how it can be used for improving therapeutic change.

2. VEPSY UPDATED: The technical approach

To produce the VR applications used in its clinical trials the VEPSY Updated project used PC-based VR platforms. The following paragraphs both describe the rationale behind this choice and detail the technical characteristics of the VR platform chosen by the project.

2.1 The emergence of PC based virtual reality

Even if the history of VR is based on expensive graphic workstations, the significant advances in PC hardware that have been made over the last three years are allowing for low cost VR systems. While the cost of a basic desktop VR system has not changed much, the functionality has improved dramatically, both in terms of graphics, processing power and VR hardware such as head-mounted displays (HMDs). The availability of powerful PC engines based on Intel's Pentium IV, AMD's Athlon and Motorola's Power PC G4, and the emergence of reasonably priced 3D accelerator cards allow high-end PCs to process and display 3D simulations in real time.

A standard Celeron/Duron 2 Ghz system with as little as 128 Mb of RAM can offer sufficient processing power for a bare-bone VR simulation, a 3.5 Ghz Pentium III//Athlon with 256 Mb of RAM, can provide a convincing virtual environment, while a dual 3.5 Ghz Pentium IV XEON configuration with OpenGL acceleration, 512 Mb of RAM and 128/256 Mb of VRAM running on Windows XP Professional, can match the horsepower of a graphics workstation[3].

Immersion is also becoming more affordable. For example, it is possible to have a basic HMD with gyroscopic head tracking built in for less than $1200. For instance, Olympus (Japan) distributes its basic video headset for about $600 without head tracking. Two years ago HMDs of the same quality were about 10 times more costly. A HMD with VGA quality and 3D video produced by a Korean manufacturer is now about $1,500. However, this price will probably decrease during the next five years.

Presently, input devices for desktop VR are largely mouse and joystick-based. Although

these devices are not suitable for all applications, they can keep costs down and avoid the ergonomic issues of some of the up-to-date I/O devices such as 3D mice and gloves. Also, software has greatly improved over the last three years. It now allows users to create or import 3D objects, to apply behavioral attributes such as weight and gravity to the objects, and to program the objects to respond to the user via visual and/or audio events.

2.2 VEPSY UPDATED: The Hardware

All the VR-based clinical modules were developed to be used on the following PC platforms:

- *Pentium IV/Athlon XP desktop VR system:*
  2500 mhz or better
  256 mega RAM or better
  minimum specification for the graphic engine: ATI Radeon 9600 128MB VRam or Nvidia GeForce 5600 128Mb VRam
- *Pentium IV/Athlon based portable VR system:*
  1500 mhz or better
  128 mega RAM or better,
  minimum specification for the graphic engine: ATI Radeon 9600 32Mb VRam or Nvidia GeForce 5600 Go 32Mb VRam

The hardware also includes:

- *A head mounted display (HMD) subsystem.* The HMDs used are:
  1. Glasstron PLM-A35/PLM-S700 from Sony Inc (http://www.sel.sony.com/SEL/). The Glasstron uses LCD technology (two 0.7" active matrix color LCD's) displaying 180000 pixels (PLM-A35: 800H x 225V) or 520000 pixels (PLM-S700: 832H x 624V) to each eye. Sony has designed its Glasstron so that no optical adjustment at all is needed, aside from tightening a two ratchet knobs to adjust for the size of the wearer's head. There's enough "eye relief" (distance from the eye to the nearest lens) that it's possible to wear glasses under the HMD. The motion tracking is provided by Intersense through its InterTrax 30 serial gyroscopic tracker (Azimuth: ±180 degrees; Elevation: ±80 degrees, Refresh rate: 256Hz, Latency time: 38ms ± 2).
  2. VFX-3D from Interactive Imaging Systems Inc (http://www.iisvr.com). The VFX-3D uses LCD technology (two 0.7" active matrix color LCD's) displaying 360000 pixels (800H x 400V) to each eye. The HMD doesn't require any optical adjustment. It can be easily worn using the patented flip-up visor. Included is also an accelerometer based serial tracker (Pitch & Roll Sensitivity +/- 70 degrees +/- ~0.1 degrees; Yaw Sensitivity 360 degrees +/- 0.1 degrees)
- *A two-button joystick-type input device* to provide an easy way of motion: pressing the upper button the operator moves forward, pressing the lower button the operator moves backwards. The direction of the movement is given by the rotation of operator's head.

To ensure the broadest user base, all the VR modules have been developed as shared telemedicine tool available through Internet (see paragraph below) by using a plug-in for the most common browsers (Explorer and Navigator) and as portable tools based on Speed-Step notebook PCs (Pentium IV/Duron, 16MB VRam and 256 Mb Ram). This choice ensures wide availability, an open architecture and the possibility of benefiting from the improvements planned for these machines by INTEL and AMD, mainly faster processors and enhanced multimedia support. Both solutions allow the support of end-users in their living environment.

2.3 VEPSY UPDATED: The Software

Each module was created by using the software Virtools Dev. 2.0 (http://www.virtools.com). Based on a building-block, object-oriented paradigm, Virtools makes interactive environments and characters by importing geometry and animation from several animation packages, including Discreet 3D Studio MAX (http://www.discreet.com), Alias Wavefront Maya (http://www.aliaswavefront.com), Softimage (http://www.softimage.com), and Nichimen Nendo and Mirai (http://www.nichimen.com), and combining them with an array of more than 200 basic behaviors. By dragging and dropping the behavior blocks together, the user can combine them to create complex interactive behaviors.

The Virtools toolset consists of Virtools Creation, the production package that constructs interactive content using behavior blocks; Virtools Player, the freely distributable viewer that allows anyone to see the 3D content; Virtools Web Player, a plug-in version of the regular player for Netscape Navigator and Microsoft Internet Explorer; and the Virtools Dev for developers who create custom behaviors or combine Virtools with outside technology. Virtools Dev includes a full-blown software development kit (Virtools SDK) for the C++ developer that comes with code samples and an ActiveX player which can be used to play Virtools content in applications developed with tools such as Frontpage, Visual Basic, or Visual C++.

Content created with Virtools can be targeted at the stand-alone Virtools Player, at web pages through the Virtools Web Player, at Macromedia Director, or at any product that supports ActiveX. Alternatively, the Virtools SDK allows the user to turn content into stand-alone executable files. Virtools's rendering engine supports DirectX, OpenGL, Glide and software rendering, although hardware acceleration is recommended.

3. VEPSY UPDATED: The clinical rationale

Up to now, the most common application of VR in clinical psychology is the treatment of phobias. The VEPSY Updated project also addressed phobias. Particularly, the Spanish group headed by Cristina Botella focused on the treatment of panic disorder and agoraphobia. The French clinical group headed by Patrick Legeron addressed the treatment of social phobia.

The overall rationale shared by the two groups is very simple: in VR the patient is intentionally confronted with the feared stimuli while allowing the anxiety to attenuate. Because avoiding a dreaded situation reinforces all phobias, each exposure to it actually lessens the anxiety through the processes of habituation and extinction.

The use of VR exposure (VRE) offers a number of advantages over in vivo or imaginal exposure: it can be administered in traditional therapeutic settings and it is more controllable and cost-effective than in vivo exposure. Another advantage of VR is the possibility of carrying out exposure to bodily sensations (interoceptive) and situational exposure simultaneously. Traditionally, exposure for panic disorder involves exposure to agoraphobic situations and interoceptive exposure that are performed in different sessions. VR allows the exposure of the patient to an agoraphobic situation (i.e. a train), and can simultaneously elicit bodily sensations through visual or sound effects (blurry vision, pounding heart, etc). In different controlled studies VRE was as effective as in vivo therapy in the treatment of acrophobia [6,7], spider phobia[8], and fear of flying [9-12].

The second clinical focus of the VEPSY Updated project was the treatment of male sexual disturbances. In particular, Optale and his team[13,14] used immersive virtual reality to improve the efficacy of a psychodynamic approach in treating male erectile disorders.

In the proposed VE four different expandable pathways open up through a forest, bringing the patients back into their childhood, adolescence, and teens when they started to experience feelings of attraction. Different situations are presented with obstacles that the patient had to overcome to continue on. VR environments in this case are used as a form of controlled "dreams", allowing the patient to express in a nonverbal way, transference reactions and free associations related to the ontogenetic development of male sexual identity. General principles of psychological dynamisms, such as the difficulty with separations and ambivalent attachments, are used to inform interpretive efforts.

The obtained results - 30 out of 36 patients with psychological erectile dysfunction and 28 out of 37 patients with premature ejaculation maintained partial or complete positive response after 6-month follow-up, showing that VR seems to hasten the healing process and reduce dropouts. Moreover, Optale used *PET* scans to analyze regional brain metabolism changes from baseline to follow-up in patients treated with VR[15]. The analysis of the scans showed different metabolic changes in specific areas of the brain connected with the erection mechanism, suggesting that this method accelerated the healing process by reopening old brain pathways or consolidating them. The results also suggest that new mnemonic associations and

rarely-used inter-synaptic connections, characterized by a particular magnitude of activation may be established, favoring satisfaction of natural drives[14].

The third part of the project focuses on obesity and eating disorders. Particularly, Riva and his clinical group led by Bacchetta and Molinari[16,17] are using Experiential Cognitive Therapy (ECT) in an integrated approach ranging from cognitive-behavioral therapy to virtual reality sessions in the treatment of eating disorders and obesity. In this approach VR is mainly used to modify body image perceptions.

What is the rationale behind this approach? Different studies show that body image dissatisfaction can be considered a form of *cognitive bias*[18,19]. The essence of this cognitive perspective is that the central psychopathological concerns of an individual influence the manner in which information is processed. Usually, this biased information processing occurs automatically. Also, it is generally presumed that the process occurs almost outside the person's awareness unless the person consciously reflects upon his or her thought processes (as in cognitive therapy).

According to Williamson and colleagues[18], body size overestimation can be considered a complex judgment bias, strictly linked to attention and memory biases for body related information: "If information related to body is selectively processed and recalled more easily, it is apparent how the self-schema becomes so highly associated with body-related information... If the memories related to body are also associated with negative emotion, activation of negative emotion should sensitize the person to body-related stimuli causing even greater body size overestimation."

It is very difficult to counter a cognitive bias. In fact, biased information processing occurs automatically, and the subjects are unaware of it. So, for them, the biased information is real. They cannot distinguish between perceptions and biased cognitions. Moreover, any attempt for convincing them is usually useless and sometimes produces a strong emotional defense. In fact, the denial of the disorder and resistance to treatment are two of the most vexing clinical problems in these pathologies[20,21].

Given these difficulties, there are only two different approaches to the treatment of body image disturbances[19]:

- *cognitive-behavioral strategies*: This approach is based on assessment, education, exposure and modification of body image. The therapy both identifies and challenges appearance assumptions, and modifies self-defeating body image behaviors[22-24].
- *feminist approach*: Feminist's therapists usually use experiential techniques, such as guided imagery, movement exercises, and art and dance therapy[25,26]. Other experiential techniques include free-associative writing regarding a problematic body part, stage performance, or psychodrama [26,27].

Unfortunately both approaches, even if effective in the long term, requires a strong involvement of the patient and many months of treatment.

The use of VR offers two key advantages. First, it is possible to integrate all different methods (cognitive, behavioral and experiential) commonly used in the treatment of body experience disturbances within a single virtual experience. Second, VR can be used to induce in the patient a controlled sensory rearrangement that unconsciously modifies his/her bodily awareness (body schema). When we use a virtual reality system, we feel our self-image projected onto the image of the visual cues (i.e. a certain figure or an abstract point, such as cursors, which moves in accordance with the movement of our own hand) appearing in the video monitor, as a part of or an extension of our own hands[28]. As noted by Iriki and colleagues[29], "Essential elements of such an image of our own body should be comprised of neural representations about the dimension, posture and movement of the corresponding body parts in relation to the environmental space. Thus, its production requires integration of somatosensory (intrinsic) and visual (extrinsic) information of our own body in space." When this happens the information itself becomes accessible at a conscious level[30] and is easier to modify.

In a case study, a 22-year old female university student diagnosed with Anorexia Nervosa was submitted to the ECT treatment[31]. At the end of the in-patient treatment, the subject increased

her bodily awareness joined to a reduction in her level of body dissatisfaction. Moreover, the patient presented a high degree of motivation to change. Expanding these results, they carried different clinical trials on female patients[32-35]: 25 patients suffering from binge-eating disorders were in the first study, 20 in the second, and 18 obese in the third. At the end of the inpatient treatments, the patients of both samples had significantly modified their bodily awareness. This modification was associated with a reduction in problematic eating and social behaviors.

4. CONCLUSIONS

How is it possible to change a patient? Even if this question has many possible answers according to the specific psychotherapeutic approach, generally change comes through an intense focus on a particular instance or experience[36]. Within this general model we have the insight-based approach of psychoanalysis, the schema-reorganization goals of cognitive therapy, the functional analysis of behavioral activation, the interpersonal relationship focus of the interpersonal therapy, and the enhancement of experience awareness in experiential therapies.

What are the differences between them? According to Safran and Greenberg[37], behind the specific therapeutic approach we can find two different models of change: bottom-up and top-down. Bottom-up processing begins with a specific emotional experience and leads eventually, to change at the behavioral and conceptual level, whereas top-down change usually involves exploring and challenging tacit rules and beliefs that guide the processing of emotional experience and the behavioral planning. These two models of change are focused on two different cognitive systems, one for information transmission (top-down) and one for conscious experience (bottom-up), both of which may process sensory input[38]. The existence of two different cognitive systems is clearly showed by the dissociation between verbal knowledge and task performance: people learn to control dynamic systems without being able to specify the relations within the system, and they can sometimes describe the rules by which the system operates without being able to put them into practice.

Even if many therapeutic approaches are based on just one of the two change models, a therapist usually requires both[36]. Some patients seem to operate primarily by top-down information processing, which may then prime the way for corrective emotional experiences. For others the appropriate access point is the intensification of their emotional experience and their awareness of both it and related behaviors. Finally, different patients who initially engage the therapeutic work only through top-down processing may be able later in therapy to make use of bottom-up emotional processing. In this situation, a critical advantage can be provided by VR.

VR can be considered a sophisticated communication interface[39]. Even if the three applications developed by the VEPSY Updated project have very different rationales, all use VR as a communication interface, able to collect and integrate different inputs and data sets in a single real-like experience. Using it accordingly, it is possible to target a specific cognitive or emotional system without any significant change in the therapeutic approach. For instance, behavioral therapists may use a VE for activating the fear structure in a phobic patient through confrontation with the feared stimuli; a cognitive therapist may use VR situations to assess situational memories or disrupt habitual patterns of selective attention; experiential therapists may use VR to isolate the patient from the external world and help him/her in practicing the right actions; psychodynamic therapists may use VEs as complex symbolic systems for evoking and releasing affect.

In fact, one of the main results of the VEPSY Updated project was the use of VR as an *advanced imaginal system*: an experiential form of imagery located between imagination and reality[40-42] that can be used to help the patient differentiate between perception and cognition. As noted by Glantz and colleagues[43]: "one reason it is so difficult to get people to update their assumptions is that change often requires a prior step - recognizing the distinction between an assumption and a perception. Until revealed to be fallacious, assumptions constitute the world; they seem like perceptions, and as long as they do, they are resistant to change." Using the sense of presence induced by VR, the therapist can actually demonstrate to the patient that

what looks like a perception doesn't really exist. Once this has been understood, individual maladaptive assumptions can then be challenged more easily.

Further, the project was developed and validated in different controlled clinical trials as well as different virtual environments used in the clinical assessment and treatment of: social phobia, panic disorders, male sexual disorders, obesity, and eating disorders. The controlled trials involved a total of *388 patients*, the largest-ever controlled study in VR therapy [44].

From the scientific point of view, the most important project's achievement was the successful integration of virtual reality therapy with traditional psychotherapy approaches, such as cognitive-behavioral therapy and psychodynamic therapy. This resulted in integrated clinical protocols that were tested in rigorously controlled clinical trials. Results have been published in many books and scientific journals such as *Clinical Psychology and Psychotherapy*, *Behavior Therapy and Experiential Psychiatry*, *Eating and Weight Disorders*, *CyberPsychology and Behavior*, and MIT's *Presence.* The quality of both the scientific and clinical work was ensured by the supervision of well-recognized experts that carried out peer evaluations of the work done by VEPSY partners (peer reviews).

However, significant efforts are still required to move VR into routine clinical use. Clearly building new and additional virtual environments - possibly networked and integrated in portable devices such as PDAs or cellular phones - is important so therapists will continue to investigate applying these tools in their day-to-day clinical practice[45]. In fact, in most circumstances, the clinical skills of the therapist remain the key factor in the successful use of VR systems.

ACKNOWLEDGMENT:

The present work was supported by the Commission of the European Communities (CEC), specifically by the IST program through the VEPSY UPDATED (IST-2000-25323) research project (http://www.cybertherapy.info).

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Telemedicine in Italy

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Summary: *The beginning of experimentation in telemedicine in Italy dates back to 1976, when The Marconi Foundation and the University of Bologna developed the first Italian electrocardiograph remote sensing prototype. Since then, a number of interesting pilot projects have been undertaken in the fields of telecardiology, teleradiology, telepathology, home oxygen therapy monitoring, emergency, teleoncology and, more recently, psychotherapy. In spite of this rapid growth and a proliferation of formal initiatives, widespread diffusion of telemedicine services has not occurred.*
To understand why, this paper explores Italian physicians' attitudes towards the use of telemedicine, with particular reference to medical teleassistance.

An analysis of responses about perceived advantages/disadvantages of telemedicine revealed that some doctors still consider telemedicine an approach of minor interest, well-suited for technology enthusiasts. Further, many physicians are not convinced that telemedicine can effectively improve clinical practice. These beliefs are deep-rooted in doctors with higher seniority, probably because they are more reluctant to accept the change of well-established clinical procedures (and also less familiar with emerging technologies than their younger colleagues).

To reduce such negative evaluations, a better circulation of information about the state of the art of research and development in telemedicine is needed, because this is the prerequisite to laying the foundations for a more pervasive culture of telehealth care in Italy.

1. INTRODUCTION:

Telemedicine means "medicine at distance" where "medicine" includes not only medical activities - involving ill patients - but also public health activities - involving well people. In other words, telemedicine is a process and not a technology, which involves many different health care activities carried out at distance[1]. Even if most of the telemedicine trials are now running in the United States, different studies are carried on in European countries. In particular, due to the geographical particularities of Italy, this country is considered a unique place to implement telemedicine services on a wide scale and the situation is progressing rather rapidly.

During the 1950's and 60's many individual experiments with medical services were carried out on the basis of telecommunication. Often it was enthusiasts with medical backgrounds who saw the possibilities as the teletechnology gradually developed. We may safely assert that those experiments were mainly directed towards the technology, even if medical and organizing matters were on the agenda. The equipment used was poorly adapted to its purpose. The predicted cost was so high that the data obtained could not be generalized to lead to safe conclusions.

Gradually the development of telemedicine moved towards solving concrete medical problems. In particular, the beginning of real world experimentation with telemedicine in Italy dates back to 1976, when the Marconi Foundation and the University of Bologna developed the first Italian electrocardiograph remote sensing prototype. In 1990, the Ministry of Universities,

Research and Technology (MURST) funded a National Telemedicine Research Programme with €50 million (about $50 million) to foster the implementation of telehealth services and to estimate their practical costs and benefits for the public sector, caregivers, and consumers[2]. Since then, a number of interesting pilot projects have been undertaken in the fields of telecardiology[3,4], teleradiology[5], telepathology[6,7], home oxygen therapy monitoring[8], emergency[9,10], teleoncology[11] and, more recently, psychotherapy[1,12], to cite a few. In spite of this rapid growth and a proliferation of formal initiatives, the widespread diffusion of telemedicine services has not occurred [13]. Yet the implementation of medical remote assistance would meet concrete needs. For example, the rapid aging of the Italian population implies an increasing need for domiciliary assistance, especially for patients suffering from chronic illnesses[14]. Considering previous experiences and the need for the development of telemedicine in Italy, what are the barriers resisting its diffusion? High costs and technical limitations have been significantly reduced and are no longer a primary barrier. Furthermore, there has been a significant increase in Internet usage by Italian doctors: in June 2002, 65% of them had an Internet connection, compared with an EU average of 64%. However, the number of Italian physicians who are using the Internet for clinical applications remains low (16% compared with an EU average of 27%)[15]. According to several authors[16,17], to understand the reason of poor diffusion of telemedicine, more attention should be paid to human factors. Currently, there is little understanding of the psychosocial and cultural implications of telemedicine technology. Indeed, research in this field often addresses the technological aspects while neglecting the needs, expectations, and attitudes of medical professionals, although it is known that acceptance of technology plays a key role in program's ultimate success[18]. The aim of the present study was to investigate the attitude of an Italian sample of physicians towards telemedicine, with particular reference to medical teleassistance. The survey took place in the Province of Milan, which represents the biggest metropolitan area in Italy. In this territory, development of telemedicine services is in an early stage[15]. The questionnaire addressed the following research questions:

- What is the current telemedicine technology knowledge/usage level?
- What is the general attitude towards telemedicine applications?
- How much money would a medical professional invest in a telemedicine application?
- Which factors predict the intention to use telemedicine?

2. METHODOLOGY:

2.1 Questionnaire

After a preliminary literature review, a focus group that included ICT experts, physicians, and psychologists was carried out to identify critical areas to be covered by the questionnaire. Then a draft was designed, developed, and tested on a small pilot sample to identify misinterpretations and reactions to the survey instrument. The final questionnaire had the following structure:

a. covering statements to explain the research project and filling instructions;
b. demographic section including items about background knowledge of ICT systems;
c. attitudes towards the use of telemedicine;
d. perceived efficacy of telemedicine in enhancing quality of care;
e. telemedicine technology section.

The definition of telemedicine used in the questionnaire was "the use of electronic information and communication technologies to provide and support health"[19]. In order to measure attitudes throughout the questionnaire, respondents were asked to indicate their level of agreement or disagreement with a given statement on a five point Likert scale. To measure physicians' technology acceptance, the definition "intention to use" was adopted following the approach suggested by Hu and colleagues in a similar study[16]. In addition, open-ended questions, closed-ended questions, and questions requiring a yes/no answer were utilized. Most closed-ended questions allowed the respondents to add their own additional response. The average time taken to complete the questionnaire was five minutes.

2.2 Participants

The questionnaire was sent to all the physicians in the Province of Milan. This area includes 188 municipalities within the Lombardy Region, with a population of almost four million people. Physician and patient demographic data are comparable to national averages: on a national level the number of physicians per 1,000 inhabitants is 2.0; in Lombardy Region it is 1.9[20]. A total of 2,987 questionnaire packets (1,140 to Milan residents and 1,847 to hinterland residents) were delivered between December and January 2003 to the targeted physicians, who were given four weeks to complete the questionnaire. A letter soliciting internal promotion of the study accompanied the survey. Physicians returned the completed questionnaires either via mail or via fax.

3. RESULTS:

3.1 Demographic data and background knowledge of ICT systems.

A total of 361 doctors out of a potential 2,950 responded to the survey (12%). Thirty-seven questionnaire packages (1.2%) were lost because of incorrect address. Respondents averaged 49.4 in age (SD = 7.1) and the majority (59%) had more than 20 years of clinical experience. Female respondents made up 28.3%. 66% of respondents were general practitioners (GP), 25% were both GP and specialists, and 8.6% had only a specialist practice. Most surveyed physicians worked for the public health system (76.7%). A few of them had both private and public practices (13.6%) and 8.3% had only private practices. In regards to background knowledge of ICT systems, 67% of respondents declared intermediate informatics skills (basic knowledge of the operating system, knowledge of at least two office applications), and 6.9% reported no informatics skills (Table 1). About 58% of respondents used to spend less than 1 hour a day surfing the Internet, 17% answered 1 to 2 hours a day, only 4% used to surf more than 2 hours a day and 20.8% never used the Internet.

Source	%
Intermediate	67.3
Low	16.3
High	9.1
None	6.9
Missing	0.3
Total	100

Table 1: Background knowledge of ITC systems

3.2 Knowledge and the use of telemedicine

Results showed that 82.5% of respondents had already heard about telehealth care. No significant correlation was found between telemedicine knowledge and demographic data such as age or gender.

Table 2 shows the principal media through which doctors got information about telemedicine (more than one option could be selected). Specialized journals (46%) and colleagues (41%) were the principal sources of information, followed by scientific meetings (25.8%), television (19.1%) and the Internet (10.2%).

Source	%
journals	46.0
colleagues	41.0
meetings	25.8
television	19.1
internet	10.2

Table 2: Information sources about telemedicine (more than one answer possible)

Only 20.5% respondents, who were informed about telemedicine, qualified as adopters by indicating previous or current use of telemedicine technology. The majority of adopters were male (80.3%) and 55.7% of them had had more than 20 years of clinical experience. 77% of adopters declared intermediate informatics skills and 55.7% of them used to spend less than 1 hour a day surfing the Internet. About 67% of adopters worked for the public health system, 21.3% had both private and public practices, and 9.8% had only private practices. When asked about frequency of use, most of them (67.2%) indicated that they used telemedicine occasionally; only 27.9% of them reported a weekly use of telemedicine. Table 3 shows which tools were used by adopters. The most cited tools were telemetry applications (66.7%)

followed by e-mail (21.7%), Internet applications (18.3%), videoconference (6.7%), and other (4.2%).

Tools	%
Telemetry applications	66.7
E-mail	21.7
Internet applications	18.3
Videoconference	6.7
other	4.2
No answer	1.9
Chat	0

Table 3: Tools used by adopters (more than one answer possible)

3.3 Perceived efficacy of telemedicine in enhancing quality of care.

The first question of this section asked doctors how much they agree with the statement "telemedicine has the potential to enhance quality of care". The answers were given on a five-point Likert scale. Results showed that on average doctors moderately agree with that statement (M=2.94, SD=0.87).

Respondents were also asked to explain their answers. Open-ended responses were coded by three independent judges. To evaluate agreement among judges, a correlation test was performed using Cohen's *K*. Resulting values were high, ranging from 0.91 to 0.96 for the final 16 categories. Table 5 shows the full list of responses. The most cited (12.2%) positive statement was: "telemedicine allows immediacy for intervention and diagnosis", while the most cited (9.4%) negative statement was "telemedicine lacks face-to-face contact between doctor and patient".

Response	1	2	3	4	5	missing	M	SD
% of total	3.9%	23%	53.2%	12.5%	6.1%	1.4%	2.9	0.9

Table 4: Potential of telemedicine to enhance quality of care (1=strongly disagree to 5=strongly agree)

Response Category	%	Cumulative %
TM allows immediacy for intervention and diagnosis	12.2	12.2
TM lacks face-to-face contact between doctor and patient	9.4	21.6
TM improves continuity of assistance (chronic patients/monitoring)	8.6	30.2
TM allows saving of time, procedures, costs, travel	8.3	38.5
TM improves continuity of communication between doctor and patient	6.1	44.6
Not classified	4.4	49.0
TM allows more exchange of clinical information at a distance	3.9	52.9
TM is generally better than traditional approach	3.3	56.2
TM provides advantages for elderly patients	2.8	59.0
TM should not be considered a replacement of traditional method of assistance	2.5	61.5
Issues related to TM technology and procedures	2.2	63.7
TM improves home-based assistance	1.9	65.7
TM improves compliance	1.7	67.3
TM encourages exaggerated conduct of patients (i.e. alarmism, hypochondria...)	1.1	68.4
TM is generally worse than traditional approach	1.1	69.5
TM usefulness is limited to a low number of cases	1.1	70.6
Missing	29.4	100.0
Total	100	100.0

Table 5: Perceived advantages/disadvantages of telemedicine

item/response	1	2	3	4	5	M	SD
TM is likely to reduce the number of examinations during surgery hours	12%	42.1%	33.5%	8.6%	3.0%	2.5	0.9
TM can improve effectiveness of therapeutic intervention	7.5%	25.2%	48.5%	12.7%	4.7%	2.8	0.9
TM can be activated through easy-to-use devices	10.5%	34.1%	42.4%	9.4%	2.5%	2.6	0.9
Making good use of TM is a deontological duty	2.8%	8.0%	38.2%	31.6%	17.7%	3.5	1.0

Table 6: Physicians' attitude towards telemedicine use in medical practice (1=strongly disagree to 5=strongly agree)

Few items focused on physicians' attitude towards telemedicine use in medical practice (see table 6). Results showed that doctors are not confident that telemedicine is likely to reduce the number of examinations during surgery hours (M = 2.5, SD = 0.9). They moderately agreed that telemedicine has the potential to improve effectiveness of therapeutic intervention (M = 2.8, SD = 0.9). Respondents were not very optimistic about the possibility of implementing a telemedicine system through easy-to-use devices (M = 2.6, SD = 0.9). However, most doctors agreed that making good use of telemedicine is a deontological duty (M = 3.5, SD = 1.0).

One set of questions focused on possible advantages telemedicine could provide to patients. Table 7 shows that on average, doctors moderately agree that telemedicine can overcome the inconvenience of going to medical surgery (M=2.8, SD=1) and that telemonitoring allows prompter intervention (M = 3.3, SD = 0.9). Moreover, doctors were moderately convinced that telemedicine provides psychological support (M=3.0, SD=1.1) and that it can foster patient's compliance (M = 2.9, SD = 1).

Another critical issue addressed by the investigation was to estimate the percentage of patients that would be willing (and able) to be involved in a telemedicine program. Results are shown in Table 8. According to the large majority of doctors (about 80%), less then 25% of their patients would be willing to try this approach. Moreover, about 80% of respondents estimated that less then 25% of their patients would be able to use telemedicine devices.

To understand which kind of devices physicians believe to be more appropriate to implement a medical teleassistance service, respondents were asked to give their preference rate on a five-point scale (1 = not appropriate; 5 = very appropriate) to different communication tools (see table 9). Telephones were given the high-

item/response	1	2	3	4	5	M	SD
TM can overcome the inconvenience of going to medical surgery	8.6%	26.6%	41.8%	16.3%	5.5%	2.8	1.0
TM monitoring allows prompt intervention	3.3%	10.5%	46.5%	29.6%	9.4%	3.3	0.9
TM provides psychological support	9.1%	22.4%	35.5%	22.7%	9.4%	3.0	1.1
TM improves compliance	8.0%	26.0%	42.7%	16.6%	5.3%	2.9	1.0

Table 7: Perceived advantages of telemedicine for patients (1=strongly disagree to 5=strongly agree)

item/response	0-25%	25-50%	50-75%	75-100%
How many patients would be advantaged by telemedicine?	82.6%	10.8%	2.5%	1.6%
How many patients would try telemedicine?	83.1%	9.1%	2.5%	1.6%
How many patients would be able to use telemedicine device?	79.7%	11.4%	4.2%	0.9%

Table 8: Estimation of patients' participation

Device	M	SD
Telephone	3.3	1.0
E-mail	2.4	1.0
Videoconference	2.1	1.0
Online instruments for clinical evaluation (i.e. questionnaires)	2.1	1.0
Chat	1.9	1.0
Sms	1.8	0.9

Table 9: Ratings of medical teleassistance tools

est rating (M = 3.3, SD = 1), followed by: e-mail (M = 2.4, SD = 1); videoconference (M = 2.1, SD = 1.1); online instruments for clinical evaluation (M = 2.1, SD = 1.0); chat rooms (M = 1.9, SD = 1.0); and sms (M = 1.8, SD = 0.9).

The last section of the questionnaire focused specifically on respondents' intention to use telemedicine technology. This part included two items. The first question asked doctors whether they would provide a telemedicine service if they would not have to pay for the enabling technologies (and for their maintenance). The second item required participants to estimate how much they would eventually invest in a telemedicine system. About 63% of respondents answered "yes" to the first question. As concerns the second question, about 54% of respondents indicated that they would not personally invest in a telemedicine system; 25% would invest from €500 to €1,000; 18% would invest from €1,000 to €2,000; and only 3% would invest from €2,000 up to €4,000.

3.4 A model of physician acceptance of telemedicine technology

A key objective of this study was to estimate a model to determine the factors which influence intention to use telemedicine (TM). The underlying hypothesis is that the intention to use telemedicine for a given individual can be predicted on the basis of selected variables. Since the dependent variable is dichotomous (yes = 1, no = 0), the logistic regression model was used to estimate factors. Predictors considered by the analysis were gender, seniority, and the following items:

- TM improves effectiveness of therapeutic intervention
- TM can be implemented through easy-to-use devices
- It is in accords with professional ethics to make good use of TM
- TM can overcome the inconvenience of going to medical surgery

Variable	B	S.E.	Wald	P	Exp(B)
Seniority	-.361	.165	4.794	.029	1.435
TM improves effectiveness of therapeutic intervention	.559	.203	7.613	.006	0.572
It is right to make a good use of TM for professional ethic	.397	.176	5.080	.024	0.672
TM can overcome the inconvenience of going to medical surgery	.346	.177	3.817	.051	0.707
TM improves compliance	.449	.196	5.257	.022	0.638
Constant	-2.787	.999	7.788	.005	16.227

Table 10. Predictors of intention to use telemedicine. Note: B is the logistic regression coefficient for the variable; Exp(b) is the odds ratio corresponding to a one unit change in variable; The Wald statistics are distributed chi-square with 1 degree of freedom.

-2 Log likelihood	Cox & Snell R^2	Nagelkerke R^2
335.964	.246	.341

Table 11: Logistic regression: model summary. Note: Cox and Snell R^2 is a measure of the fit of the model, defined as $1-[L(0))/L(B^\wedge)]^{2/N}$, where L(0) is the likelihood of the intercept-only model, L(B^) is the likelihood of the full model, and N is the estimated population size. Nagelkerke R^2 measures the absolute percentage of variation explained by the model.

- Telemonitoring allows prompt intervention
- TM provides psychological support
- TM improves compliance
- TM is likely to reduce the number of examinations during surgery hours

To identify which of these factors are included in the final regression equation, forward stepwise selection (Waldesian) for logistic regression was used. The results of this analysis (tables 11-12) indicate that a model including seniority and responses to items: "TM improves effectiveness of therapeutic intervention"; "making good use of TM is a deontological duty"; "TM can overcome the inconvenience of going to medical surgery"; "TM improves compliance", was statistically significant in predicting intention to use telemedicine, c^2 (5, N = 337) = 95.32, p = .001. As shown by the classification table (see table 13), the model predicts 79.8% of the responses correctly (90.6% of "yes" and 58.8% of "no"); the absolute percentage of variation explained by the model (Nagelkerke R^2) is 0.34.

4. DISCUSSION:

The survey sample was made up of 361 spontaneously returned questionnaires. The fact that on average respondents were 50 years old, were well-informed about telemedicine and had 20 or more years seniority suggests that doctors surveyed were in a sound position to provide feedback to the possible improvements that telemedicine may (or may not) deliver to their practice.

About half of the physicians moderately agree that telemedicine has the potential to enhance quality of care. Immediate response, easier accessibility, lower costs, and time saving were the main benefits noted by respondents. However, several doctors underlined potential shortcomings of telemedicine, emphasizing in particular the importance of having face-to-face contact with patients. These observations suggest that although many physicians recognize the advantages of telemedicine, they also question the potential of this technology to replace traditional ways of diagnosis, intervention, or treatment. This moderately positive attitude is reflected by the results of Section II, which focused on the possible advantages that telemedicine could provide to patients. According to the majority of respondents, telemedicine consultation could enhance quality of care by improving promptness of intervention, overcoming the inconvenience of going to medical surgery, providing psychological support, and fostering compliance. However, perceived advantages for patients and estimates of patients' participation

	Predicted		
Observed	**Intention to use telemedicine**		**Percentage correct**
	YES	NO	
YES	202	21	90.6
NO	47	67	58.8
Overall Percentage			79.8

Table 12: Logistic regression: classification table

were quite discouraging: according to the large majority of doctors, less than 25% of their total patient care would be assisted by telemedicine; moreover, respondents indicated that less then 25% of their patients would want to be involved in a telemedicine program. These rather conservative estimations can be interpreted in different ways. First of all, it is likely that only a few patients of the doctors included in this sample need therapy monitoring or frequent changes in management. Another reason could be found in the doctors' lack of confidence in their patients' ability to handle telemedicine devices. Indeed, telephones were indicated by doctors as the more appropriate device for telemedicine, while more sophisticated and powerful communication technologies such as the Internet and its various applications (email, chat, videoconference, etc.) were given lower ratings. Besides usability aspects, there are further reasons that may explain this preference. First, the telephone is a standard feature in most Italian homes, and with the more recent advent of mobile phones the Italian population has even readier access to communication by telephone. Moreover, telephones have been used on a routine basis in professional practices for a number of decades (i.e. for giving and receiving referrals, scheduling patients, and providing emergency care), while the clinical use of the Internet, whether through e-mail, chat rooms or via audio or video connection, is not yet widespread. As concerns Internet-based technologies, results showed that e-mail is considered the best alternative communication tool for patients and providers, although its average score was low (2.4 on a 5-point Likert scale). This may reflect doctors' concerns regarding the technical and day-to-day aspects of actually integrating e-mail into clinical practices. These concerns are usually related to the potential for increased demand on physician time (particularly with the overuse of e-mail by patients), generating timely responses, inappropriate or urgent content in the messages, and confidentiality issues[21].

Results showed that 63% of respondents would accept telemedicine if all the devices were provided for free. Moreover, 97% of potential adopters indicated that they would be willing to invest less than €2,000 in a telemedicine platform. This data indicates that cost reduction is still a critical issue in promoting the adoption of telemedicine. As regards factors affecting intention to use telemedicine, the logistic regression model (see Tables 10 and 11) indicates that: (1) physicians with higher seniority are about 1.5 times less willing to use telemedicine than colleagues with lower seniority; (2) doctors who are more confident about the potential of telemedicine to improve effectiveness of therapeutic intervention are more willing to adopt this technology; (3) the more doctors believe that making good use of telemedicine is a deontological duty, the higher their interest is in using this approach; (4) physicians who are more confident about the potential of telemedicine to improve patients' compliance are also more willing to adopt it. It is interesting to note that with the exception of seniority all predictors have in common the perceived advantages for patients. This confirms that the propensity to use telemedicine is higher for those professionals who are more persuaded by the added value of telemedicine in improving quality of care [16].

5. CONCLUSION:

The aim of this study was to investigate physicians' attitudes towards the use of telemedicine. As with all pioneering research there are limitations. Further longitudinal research is required at various levels and on a national scale before national/regional average comparisons can be made. However, outlining the situation allows us to draw from the findings some rough guidelines and indications for improving the situation. An analysis of responses about perceived advantages/disadvantages of telemedicine revealed that some doctors still consider telemedicine an approach of minor interest which is well-suited for technology enthusiasts. Further, many physicians are not convinced that telemedicine can effectively improve clinical practice. These beliefs are deep-rooted in doctors with higher seniority, probably because they are more reluctant to accept the change of well-established clinical procedures (and also less familiar with emerging technologies than their younger colleagues). To reduce such negative evaluations, a better circulation of information about the state of the research and development in telemedicine is needed, because this is the prerequisite for laying the foundations for a more pervasive culture of telehealth care in Italy. This concerns issues related to technology usage and learning, and there is a compelling need to improve the usability of these devices[22] and the set of core

competencies and knowledge that are required to productively operate telemedicine technology. This could be achieved by increasing the provision of specialistic training to the operators. At present, only one post-graduate master in Telemedicine and E-Health is available at Politecnico di Milano [19]. The outcomes of logistic regression model indicate that in order to overcome physicians' doubts towards telemedicine it is important to maintain the centrality of the patient in the evaluation of telehealth programs. Rather then relying solely on service utilization data, a common practice in managed care, the goal of a patient-centered evaluation is to understand the human impact and meaning of the change in the service patterns [17]. Finally, as recently indicated by the final report of the EU-funded project VEPSY (Virtual Environments and Telemedicine in Clinical Psychology, IST-2000-25323 [23]), it is necessary to develop an appropriate health administration policy that supports at both financial and organizational levels, the implementation of telemedicine services. In conclusion, the results of this study confirm that attitude is an important determinant of physician acceptance of telemedicine and emphasize the strategic importance of collecting psychosocial information to offer insight about how to improve the use of telehealth systems.

6. ACKNOWLEDGEMENTS

The present work was supported by a Fondazione Cariplo grant (TELECRON Project, 2002-2003) and by the Italian Ministry of University and Research FIRB grant (Project NeuroTIV).

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Evaluating Psychiatric Patients Using High Fidelity Animated Faces

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Abstract: *We describe the development and early clinical testing of a novel psychiatric assessment tool that animates 3D faces of virtual humans in real-time to evoke and measure emotional responses of psychiatric patients. The purpose of this new tool is to create a screening protocol where repeatable and parametric facial stimuli are presented interactively to patients in order to characterize and later identify their respective mental disorders using their measured responses. The computer system, presented herein, uses photo-realistic animated 3D models of human faces that display basic emotions, which can be most reliably recognized from facial expressions. The patients' ability to recognize these basic expressions (neutral, happiness, surprise, fear, anger, disgust or sadness) is used as an indicator of their mental health and mapped onto scientifically evaluated symptoms of the respective brain disorders. This paper presents our early clinical results demonstrating that the new assessment tool can be effectively used to screen patients for a group of well-defined psychiatric disorders.*

1. INTRODUCTION:

Recognizing an emotion shown in a face involves many different brain structures responsible for both perceptual processing and the recognition of facial components [1]. Various stages of emotional processing represented different evolutionary advantages and thus developed at different times [2, 3]. This distributed architecture gives rise to the possibility of studying various disorders of the brain by the simple means of facial image animation.

Clinical psychologists have long used facial photographs to study their patients. As an example the Szondi Test [4] - which is used to detect psychiatric disorders - is a projective technique based on a person's reaction to a series of 48 photographs of psychotic patients. The photographs were chosen in accordance with the principle of genic relationship; that is, the person assumedly selects a photograph which portrays a psychiatric disorder also inherent in the subject's own familial genealogy. Similarly, it is well documented that Depression can be detected as a cognitive bias in emotion [5, 6]. In fact, when a depressed patient is asked to select a "neutral" face from a database, he or she tends to choose faces that are approximately 15% biased towards sad faces.

The diagnosis of Alzheimer's disease currently "depends on clinical acumen more than objective biological markers" writes N. Relkin in [7]. Early research suggests that AD patients tend to be particularly impaired in the central executive component of working memory which effects facial processing [8]. In fact a possible explanation comes from MRI imaging studies that have shown that the average brain shrinkage in patients with AD has been found to be 2.5% per year, compared to 0.4% for age-matched normals [9]. Recently, strong evidence came from a study of 22 AD patients who were significantly impaired on tasks of facial emotion matching [10]. In particular, the ability to recognize sadness, surprise and disgust was more impaired than recognition of happiness, fear and anger. The progression of many other diseases related to the aging or the damage of certain areas in the brain can be detected and qualitatively evaluated through processing facial emotions. Subjects with Obsessive-compulsive disorder are impaired disproportionately in the recognition of disgust [11]. Some studies reported impaired recognition of facial emotions in patients

with Parkinson's disease (although other studies failed to support that conclusion) [12]. Strong evidence supports the disproportionate impairment in recognizing disgust from facial expressions in persons with Huntington's disease [13, 14]. Further examples include Schizophrenia [15], Autism [16] and Multiple Sclerosis.

2. THE PSYCHO DISC DEVICE:

Recent advances in computer animated humans [17], and in particular high fidelity facial modeling and animation technology, have laid the foundation to create novel clinical applications relying on "virtual patients" [18] that can be digitally controlled to express subtle emotions in a time-varying manner.

The Psycho Disc Device (PDD) employs a circular interface with the neutral position represented in the center and 6-24 3D examples of the six basic facial emotions on the periphery. The 3D emotion examples are high fidelity, photo-real facial models that were created using a large 3D database of people. The user may navigate in this "emotion space" [19, 20] by moving a pointing tool, such as a mouse, a game pad or joy stick.

Doctors may use the device to create specific psychological tests to measure the timing and reaction of their patients to any given sequence of emotional stimuli, thereby allowing them to diagnose their patients' respective psychological disorders. The *PDD* provides a unified platform for designing new psychiatric diagnostic tests that involve facial emotion recognition tasks. These experiments may focus on multiple aspects of the recognition process, including (i) temporal transition from one expression to others, (ii) the effect of viewing angle, (iii) latency in the recognition of particular emotions, (iv) famous & known vs. unknown people, (v) inconsistent emotions, and (vi) static recognition tests, thus providing a very detailed and refined parametric model and description of patients and their respective disorders.

A major advantage of using the PDD is that it maps individual patient characteristics onto a well defined mathematical space in which signatures of particular disorders may be recognized using statistical methods. It is this output that finally provides a *standardized*, *parametric* and *repeatable* data set that can be used by psychologists and researchers to finely map and correlate a large number of mental disorders to the mental state and early symptoms, possibly even before the full onset of the disease itself.

3. EXPERIMENTAL PROTOCOLS:

Our investigation focused on creating a medical screening protocol where the repeatable PDD method and parametric facial stimuli are presented interactively to a group of patients in order to characterize and later identify their respective mental disorders using their measured responses.

The purpose of this investigation is to verify theoretical results and gather evidence that disorders, under clinical circumstances, may be differentiated solely based on the degradation in performance of recognition and the directions of mistakes in recognition when compared to the control group.

In the experiments we used high fidelity, photo realistic digital replicas of a male and a female face capable of expressing fine tones of neutral and six basic emotions (happiness, anger, sadness, disgust, fear, surprise). Their circular arrangement conformed to the findings of describing how transitions occur in emotion space.

In our preliminary experiments we evaluated 10 schizophrenic and 5 depressed patients and compared them with a control group of 10 normal subjects. All of the non-control subjects are in patients, the inclusion criteria were as follows:

- all subjects were between the ages of 18 and 35 years
- schizophrenic patients included in the experiments must have had a positive BPRS
- all depressed patients had to have at least 15 points in Beck depression scale
- all controls had to fill in the SCL-90 and had to have a negative psychiatric anamnesis

Before starting each experiment we first had all the subjects sign a release statement (permission) and provide collected personal and medical data (name, age, male, address, phone number, qualification, clinical diagnosis (DSM-

N(PICTURE ID)						
Neutral	Happiness	Surprise	Anger	Disgust	Fear	Sadness
Expressionless	Joy	Amazement	Wrath	Distaste	Dread	Sorrow
Glassy	Pleasure	Astonishment	Furious	Loathing	Awe	Unhappiness
Toneless	Smile	Revelation	Spite	Abomination	Apprehension	Gloom
Pudding-face	Laugh		Irate	Abhorrence	Dismay	Tribulation

Table 1: Expression table used in Experiment #1

IV), medicines taken, etc.) for later analysis. Each subject was asked to carry out two different tests (see below) and their performance was measured on a point scale to assess their respective performance.

- In Experiment #1 we used frontal views of the two 3D animated heads and asked the subjects to identify emotions as they appeared briefly on the screen. We recorded two separate sequences (7 pictures each), one with textured models and the second one without textures on them (gray heads). We have used a table with the names of the basic emotions and their synonyms. Patients were given the following instructions: *"We will be showing pictures of faces, expressing different emotions on the computer screen. Your task is to choose and mark the appropriate emotion from this table in front of you. Each table corresponds to one picture and you may mark only one expression at a time. Each column of the table consists of synonyms of one basic emotion."* (See Table 1 for details)

- In Experiment #2 we created slowly varying emotional displays that gradually changed from the neutral position towards their respective 100% activation values in a 5 second period.

Test 2.							
Number of the animation	Happiness	Surprise	Anger	Disgust	Fear	Sadness	Frame number
Frontal Views							
1							
2							
3							
4							
5							
6							
3/4 profile Views							
7							
8							
9							
10							
11							
12							

Table 2: Expression table used in Experiment #2

Subjects were asked to start and later stop the animation sequence by first pressing and releasing a button when they recognized any emotion on the digital face. Before starting the experiment, the following specific instructions were given to each of them: *"You are going to see an expressionless face on the monitor. When you push this button the face will start changing its expression smoothly. At some point it will begin to show an emotion. When you recognize what emotion it is you should release the button and find it in the table for me to mark it."* This experiment was carried out with textured 3D head models in two batches viewing them both from frontal and ¾ profile directions, respectively. (See Table 2.)

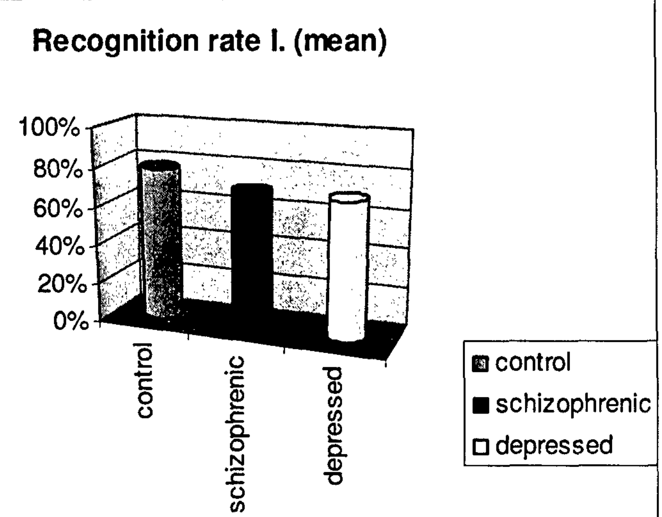
Finally, when both tests were complete, each subject had to fill out a short questionnaire to record their opinions and general feedback on the tests themselves. This questionnaire included questions such as "*Was the test boring or exciting, long or short, etc.*"

4. RESULTS:

Tables 3 through 5 show the results of the two experiments described in the preceding section. Based on statistical analysis of the data collected our most important finding is that even at this relatively small sample scale of the patient population and the control group we have found measurable difference in the recognition rate. Specifically, control persons had an average score of 78.5%, while depressed ($p=0.021$, deviation=8.22) and schizophrenic persons ($p=0.062$, deviation=16.92) had an average of 70%. Significance (p) values are relative to control group. (Table 3.)

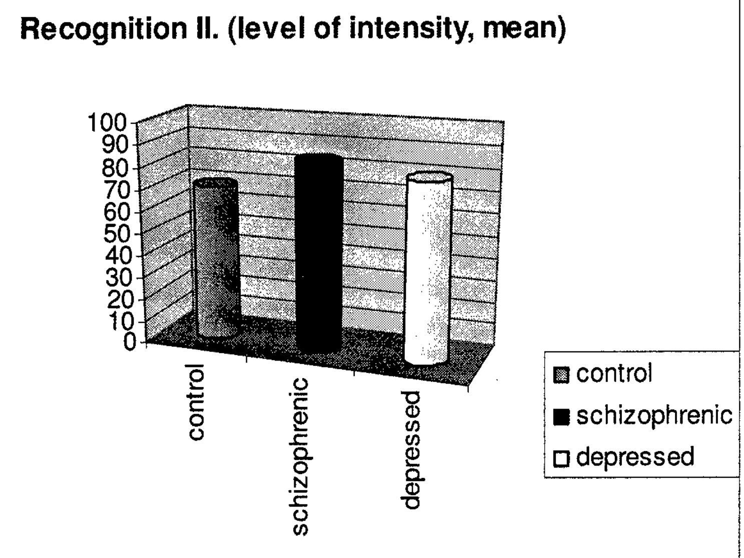
We also found significant difference in the second experiment, more precisely in the average intensity levels of emotions when subjects recognized them. In particular, control persons in this experiment (#2) had an average score of 74%, while depressed patients ($p=0.080$, deviation=11.27) scored 80% and schizophrenics ($p=0.015$, deviation=11.92) scored 84% on the average. The significance values (p) are relative to control group. These results are shown in Table 4.

Although the main aim of the research described herein was to find and clinically prove that differences exist between the control and inpatient group when recognizing digitally created basic emotions, we also had a secondary



	control	schizophrenic	depressed
Reconition	78,57%	70,36%	70,00%

Table 3: Statistical results obtained from the static emotion identification experiment (Exp. #1).



	control	schizophrenic	depressed
Recognition	70,22	84,32	79,83

Table 4: Statistical results obtained from the dynamic/time-varying emotion intensity recognition experiment (Exp. #2).

goal: to find out what other aspects influence the very process of emotion recognition itself. These results are summarized in Table 5. As a general conclusion we found the following:

- Expressions on the gray models (i.e. only shape information without facial texture) are more difficult to recognize than others.
- Recognition rates of particular expressions were almost the same whether they were presented from a frontal or ¾ profile view.
- The shorter an emotion is displayed (Test I.), the more difficult it becomes to recognize it.

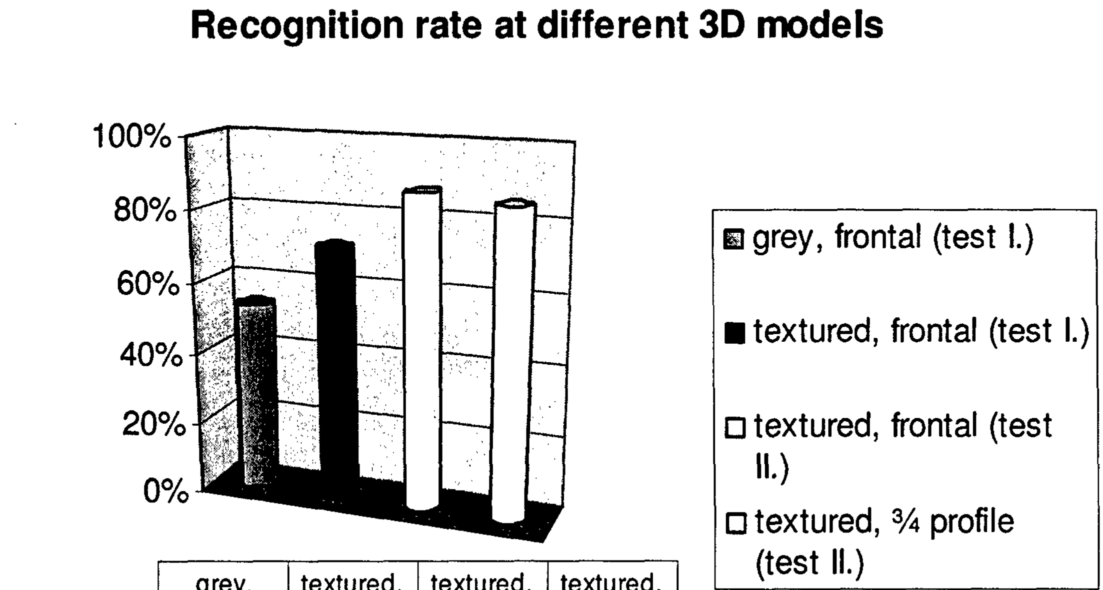
5. CONCLUSION:

In this paper we described our preliminary clinical experiments using a novel method, called Psycho Disc Device or PDD, of diagnosing psychiatric disorders. The PDD uses animated, high fidelity faces to provide an objective and parametric assessment of patient performance. Using a small group of schizophrenic and depressed patients as well as a control group of healthy individuals, we managed to show statistically measurable differences between the respective population and therefore gather evidence that the PDD may be used as an efficient method to screen patients for a variety of psychiatric diseases. Our specific findings can be summarized as follows:

- Evaluation of the data collected provided evidence that Schizophrenic and Depressed patients consistently showed differentiable degradation in performance when compared to the control group on all tests carried out.

- We examined two aspects of performance (recognition rate, and the level of intensity by recognition). We found significant difference ($p = 0.021$) between depressed subjects and the control group in the first aspect, and a significant difference ($p = 0.015$) between schizophrenics and the control group in the second aspect.

Finally, we noted that significant performance difference was recorded when using gray or non-textured models vs. textured ones.



	grey, frontal	textured, frontal	textured, frontal	textured, ¾ profile
Recognition	53%	71%	87%	85%

Table 5: Comparison of recognition rates as a function of 3D facial model quality.

Based on the above, we conclude that PDD is a promising new way to screen populations for psychiatric disorders. In the future we will continue our research by testing the protocol on a larger number of people and by verifying the results presented here. We are also planning on updating the protocol and designing new experiments that may better show the difference between healthy and affected people. Finally, a set of new experiments focusing on other psychiatric disorders is also in development.

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A Virtual Supermarket to Assess Cognitive Planning

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Abstract: *Patients with diffuse or focal cerebral lesions encounter cognitive planning alteration that interferes with social and professional activities. Standard cognitive tests of detection have some difficulties in predicting what occurs in patients' everyday life and seem inadequate in terms of sensitivity or specificity.*

Virtual Reality offers the capacity to assess patients in situations close to their daily activities, thanks to the safe and controlled progress of the patients in a Virtual Environment (VE). Moreover, the introduction of gaming factors may improve the motivation of subjects.

We present our approach in cognitive planning assessment for patients with Parkinson's disease. We designed a fully textured Virtual Supermarket (VS) in which the patient can freely move behind a cart and execute precise tasks. During a session, we record all the efficient and inefficient actions of the patient, her/his errors and her/his regular positions in the VS. We also developed an analysis procedure of all the recorded data.

The performances collected among six patients were compared to those of five healthy volunteers in order to validate this approach and to evaluate its sensitivity.

Executive function disorders are difficult to categorize. Many studies emphasize the requirement for accurate cognitive assessment and for rehabilitation cognitive methods relevant to the patient's real world. We expect that the techniques of virtual reality should allow significant progress in the prediction of action planning in everyday life. The ecological characteristics of our environment allow further use for behavioral training.

1. INTRODUCTION:

The cognitive disorders of neurological pathologies constitute a major problem of public health, consequently, the detection and the rehabilitation of these deficits must be adequate, and occur as early as possible[1]. A major criticism emitted against work carried out to date is that the traditional cognitive tasks are very far away from the everyday situations. These issues are especially important for neurological pathologies in which the cognitive alteration induces an important social and professional impairment, like Parkinson's disease (PD)[2, 3]. This degenerative pathological entity is characterized by an extrapyramidal syndrome combining akinesia, rigidity, tremor and axial signs. However, PD patients frequently develop cognitive dysfunction even at the early stages of the disease[4]. This impairment predominantly involves the executive functions, largely sustained by the prefrontal cortex and related to deficits in control of attention, planning, capacity to elaborate a strategy, set shifting, and working memory[5]. Furthermore, among the cognitive functions, planning is omnipresent in the everyday life and is the most important component of cognitive PD alteration[6]. This cognitive process is an executive component which ensures the fitting and the spacetime scheduling of the various stages necessary to a particular plan of action. Different but complementary models were proposed[7-10]. One of the significant concepts introduced here with regards to planning is that of schemas of ac-

tion[7]. The schema corresponds to an elaborate cognitive representation during various sensorimotor and intellectual experiments of the subject: it is composed of units of articulated circumstantial elements. If the articulation of these units generally works in a stereotyped way, it remains flexible and able to adapt to the external constraints. The traditional executive tasks do not make it possible to explore such concepts, and they are frequently inefficient in terms of sensitivity or of specificity[7, 8]. These tests in particular leave little initiative to the subject. Some ecological paradigms were built to rectify this situation[7], but as they are held in real time and in a real environment, this considerably limits their use, especially for patients who are not physically autonomous. The modeling of planning, as presented above, and the need for the ecological character of the tests contributed to the emergence of new cognitive tests, whose scripts try to relate the assessment with equivalent daily life behavior. In fact, the test of scripts[8-10] consists of a sequential and hierarchical organization of actions referring to a particular situation (for example, to go shopping). These paradigms, while placing the subject as far as possible in current situations, aim at better understanding the deficits which are expressed in a specific way in the daily activities, as well as a better apprehension of the complex interactions of cognitive disturbances which have occurred within these activities. However, it is realized that without any production of action, the subjects have to generate verbally what they are supposed to do.

The recent advent of virtual reality technology allows the presentation of scenarios or scripts that are ecologically valid (i.e. very close to the situations of life)[9, 10]. The technology of the virtual environments has the capacity to create sets of 3D dynamic stimuli, inside of which all the behavioral answers can be recorded and measured; in addition the introduction of the gaming factors into the cognitive evaluation improves the motivation of subjects[11, 12]. It has also been shown that active patient participation is a key factor in successful rehabilitation[13]. Finally, such an environment makes it possible to optimize the training, the generalization and the transfer of acquisitions towards the real world[14, 15].

2. PROJECT GOALS

Since we intend to provide indications on the cognitive capacities in everyday life, it seems of higher interest to conceive situations of diagnosis which maintain the characteristics of the real situations, while preserving criteria of standardization necessary to any evaluation. We propose to evaluate planning thanks to a 3D environment built on the model of scripts described above.

2.1 The tasks and the environment

We developed an original paradigm similar to the "test of shopping list"[16] in a supermarket, which foresees a series of actions: concretely, the patient should buy a certain number of products. The search for a particular object (for example, a cleaning product) allowed the clinicians to analyze the strategic choices made by the subject and thus the capacities of planning.

We wanted to analyze the visuospatial as well as the temporal aspects of planning. The correct responses and the errors were recorded.

2.2 Target population

This methodology was applied first in a pilot study on old, healthy subjects and patients suffering from PD.

The PD patients were referred by a neurologist (RMM) and selected from out-patients at the Neurology Department of the University Hospital of Caen, France. They were included in the study according to the following inclusion criteria:

- Age ≤ 80 years;
- Ability to read and write French, with more than five years of education;
- Idiopathic PD, according to the criteria of Gelb[17];
- Only L-DOPA and dopamine agonists allowed as anti-parkinsonian therapy;
- Good response to therapy;
- Lack of dementia as evaluated by the DSM IV[18];
- Hachinski modified vascular score less than two;

- No known history of brain or thyroid gland disease, alcoholism, use of psychotropic major agents, or depression as measured by a Montgomery and Asberg Depression Rating Scale score below six[19].

The severity of clinical symptoms (mild to moderate: stage 1 to 2.5) were assessed on dopaminergic medication using the Hoehn and Yahr scale[20].

The control subjects were included in the study according to the following inclusion criteria: Age ≤ 80 years; ability to read and write French, with more than five years of education; lack of depression and dementia as evaluated by the DSM IV [25]; Hachinski modified vascular score less than two; no known history of brain or thyroid gland disease, alcoholism, or use of psychotropic major agents, as evaluated using a clinical examination and a medical questionnaire.

2.3 Assessment's tools

The evaluation of global intellectual efficiency was carried out thanks to the scale of Mattis[21] which explores through its sub-scores the following cognitive processes: attention, initiation, capacities of conceptualization and memory.

The classical exploration of the Executive Processes was done with a validated executive battery that includes the Wisconsin Card Sorting Test[22], the Brown-Peterson Modified Paradigm[23], the Stroop test[24], and Verbal Fluency[25].

3. MATERIALS AND METHODS

3.1 Equipment and Software

The system configuration is a Compaq Minitour, Processor Intel 2.4 GHz, 512 MB of RAM, Video card GE Force4 MX420 64Mo, and a plug-in to visualize the virtual worlds. Such equipment can be made available in every hospital environment.

The virtual world images are displayed on a large screen monitor. The patient navigates in the world either with the keyboard or with a Wingman Logitech game pad. The patient interacts with the artifacts with the mouse or the game pad.

We used two main software tools to create the 3D virtual exposure environment. We designed the objects, the visual effects, and the virtual worlds with Discreet 3D Studio Max 4. The 3D design was then integrated in a behavior-based interactive 3D development tool, Virtools Dev, which allows the implementation of behaviors through scripts.

The environments are running on PC and can be viewed with the freely downloadable Virtools Web Player (www.virtools.com).

3.2 The Virtual Environment

The Virtual Supermarket (VS) was designed to train action planning in PD. It simulates a fully textured medium size supermarket with multiple display stands for drinks, canned food, salt food, sweet food, cleaning equipment, clothes, stationery and flowers; refrigerators for milk and dairy products; freezers; four more specific stalls for fruits and vegetables, meat, fishes and bread; four cash desks; a reception point and a cart (Figure 1 and 2). Some obstacles, like packs of bottles or cartons were designed to hinder the advance of the patient in the different paths. They can be removed if the patients feels it is too difficult to move around. We introduced some characters in the supermarket such as a fishmonger, a butcher, checkout operators and some customers.

The patient enters the supermarket behind the cart and moves freely inside. Her/his first task is to buy a clearly defined list of products, to go to the cash desks and to pay. Other tasks could be defined later.

We let the patient experience the environments from a *first person perspective* without the intermediary of an avatar. The patient is represented by a 3D Frame (a reference point) bound to a camera and to the cart. They move together because of a hierarchy link. The collision tests between the patient and the objects of the environments are managed by the cart, which is also bound to be on floor.

The patient navigates in the virtual supermarket using the cursor movement keys or a Wingman Logitech game pad. These devices allow translation and rotation movements.

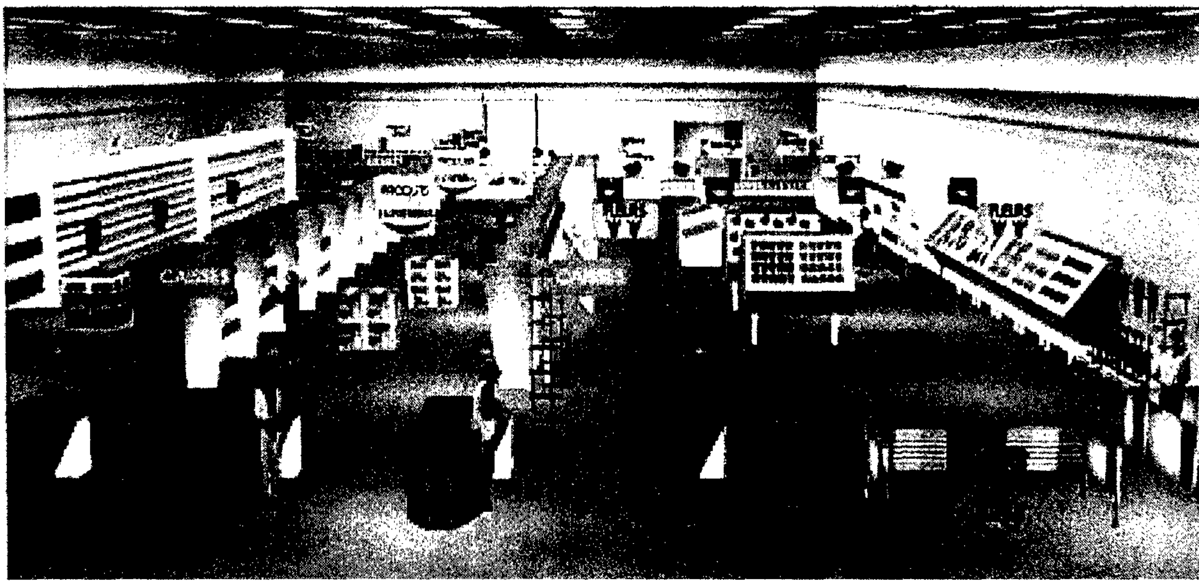

Figure 1: Supermarket front view

The patient is free to pick up products by pressing the left mouse button. If they appear in the list defined by the therapist, they are moved to the cart. At the cash desk, the patients can put the products on the conveyor belt and put them back in the cart by pressing the left mouse button on the belt. Finally, by clicking on the purse, the patient can pay and go to the supermarket's exit.

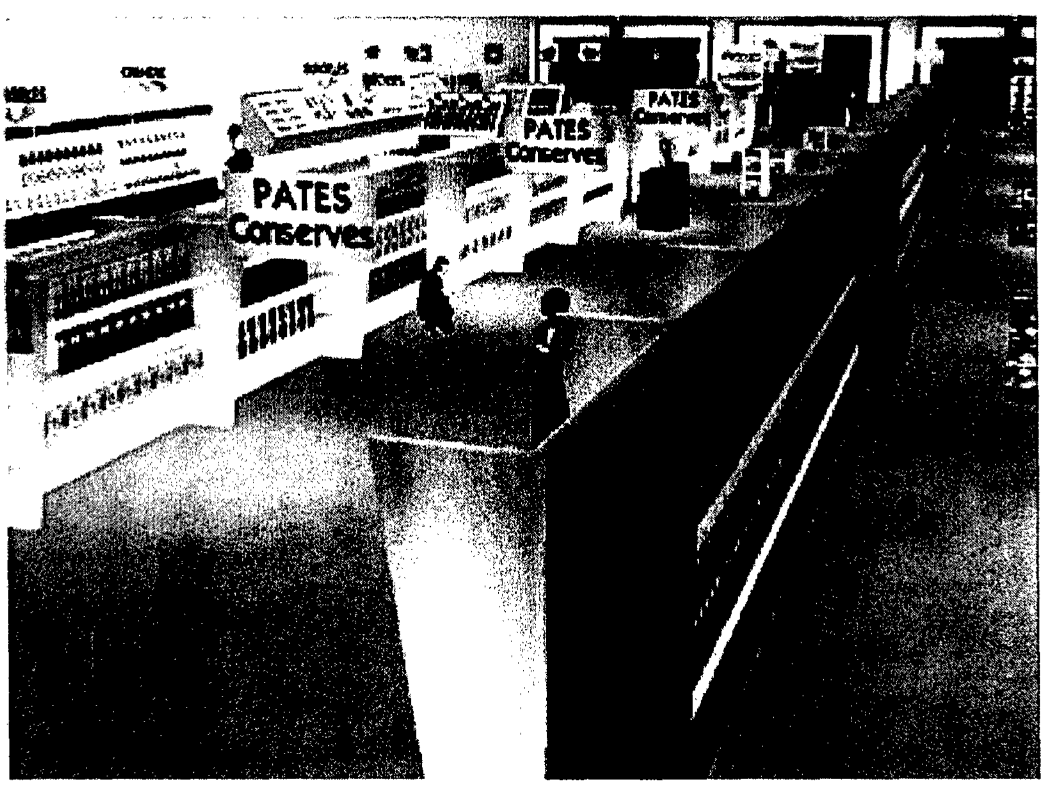

Figure 2 : Supermarket back view

3.3 Session's unfolding

During two preliminary training sessions, the patient learns to move in the virtual supermarket, to recognize the various places and to pick up objects which are different from those on the therapist's list.

Then the patient enters the supermarket for a cognitive planning evaluation. Her/his task is to buy a clearly defined list of products, to go to the cash desks, and pay. The instructions related to the task are, at first, written on the screen and the defined products are shown in the right part of the screen. As the patient progresses with her/his purchases, the products appear in the cart and disappear from the screen. The instructions related to cash desk area are verbal and given before the beginning of the session.

3.4 Recording and measurement

For the purpose of further analysis, the system records and measures various parameters while the patient experiences the virtual environment. All the patient actions are recorded. If the patient chooses goods that are not in the list, her/his action is recorded as a mistake. The patient can leave the supermarket without buying anything, without paying. The patient can also stay in the supermarket. All these situations are recorded.

We also measured and recorded the duration of the session and the trajectory of the patients.

4. RESULTS

Our preliminary study compared six PD patients (2 females, 4 males) to five control subjects (4 females, 1 male). All the subjects were included according to the respected inclusion criteria previously defined in this paper. The mean age of each group was 74.0 years (SD = 5.4) for PD patients and 66.6 years (SD = 7.7) for control subjects. Mattis mean score was 136.4 (SD = 6.6) for PD patients and 139.8 (SD = 4.1) for controls, which is consistent with a preserved global intellectual function of our patients. All the recorded data (means and standard deviations) are shown in Table 1. Interestingly, all the patients' performances are lower than the controls data.

On this small group, only the covered distance and the duration of the test are significantly altered. The trajectory, shown in the Figures 3 and 4, demonstrates that numerous stops and turning around the same shelves seems to be characteristic of the PD patients.

	PD Patients N= 6 (2 F, 4 M)	Controls N= 5 (4 F, 1 M)
Age	74.0 ± 5.4	66.6 ± 7.7
Mattis Scale	136.4 ± 6.6	139.8 ± 4.1
Distance (m)	343.1 ± 113.9 *	224.8 ± 36.4
Duration (min)	20.4 ± 8.2 *	10.4 ± 1.3
Stops Number	56.6 ± 32.9	25.4 ± 3.5
Mean Stop Duration (sec)	13.4 ± 2.3	12.3 ± 2.3
Time to Pay (sec)	14.6 ± 12.8	5.7 ± 8.1
Good Actions	11.6 ± 1.5	12.0 ± 0.0
Intrusions	3.6 ± 3.3	2.0 ± 0.7

Table 1: Means and standard deviations of the recorded data

* : $p < 0.05$, significant difference between the two groups, using the non parametric Mann-Whitney test.

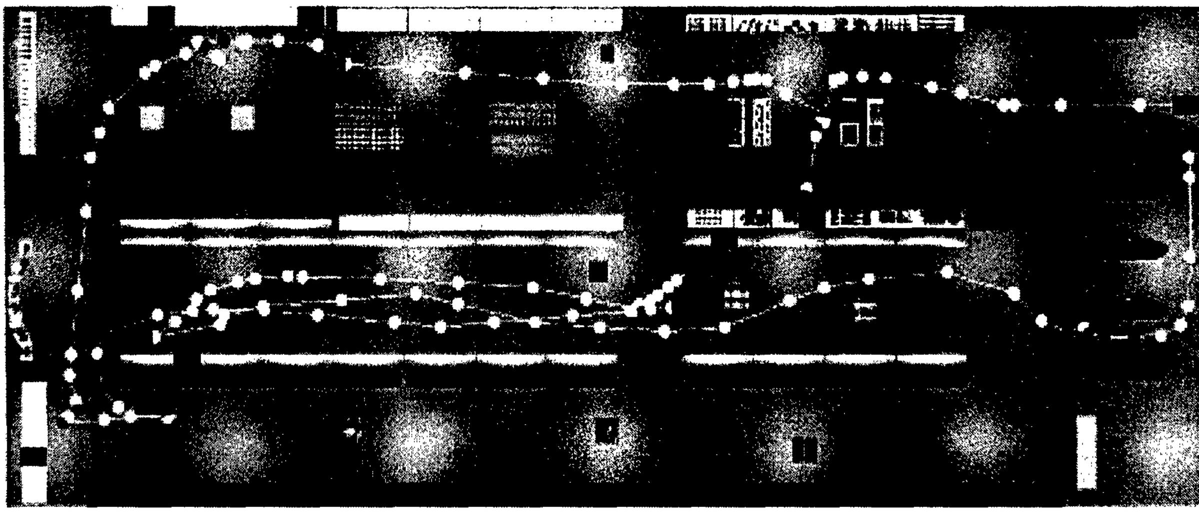

Figure 3: Trajectory of a control subject

5. DISCUSSION

A specific alteration of executive function is a well-known trait of PD[4, 26]. However, planning deficit, although often reported in PD (using the tests of Towers, for example), was not perfectly clarified as the mechanism (i.e. alteration of planning latency or accuracy and of shifting processes). The tower of London, developed by Shallice to assess planning capacities, is a paradigm in which the subject must move colored balls to match a specific arrangement in the minimum number of moves possible. Using this task, Morris showed that PD patients do not make more moves than those required to resolve problems as compared to controls, but show slowness in the initial thinking time (time between the presentation of the problem and the first movement). The authors interpreted these results as a difficulty to elaborate an action plan, a deficit which essentially concerns the anticipation of the optimal solution. Taylor et al suggested that the principal cognitive deficits in patients with PD occurs in tasks involving "self-directed behavioral planning," although in a later study involving patients with mild PD no deficits were found using a three disk planning problem solving similar in design to the Tower of London test. The fact that patients with mild PD were not impaired in terms of accuracy of

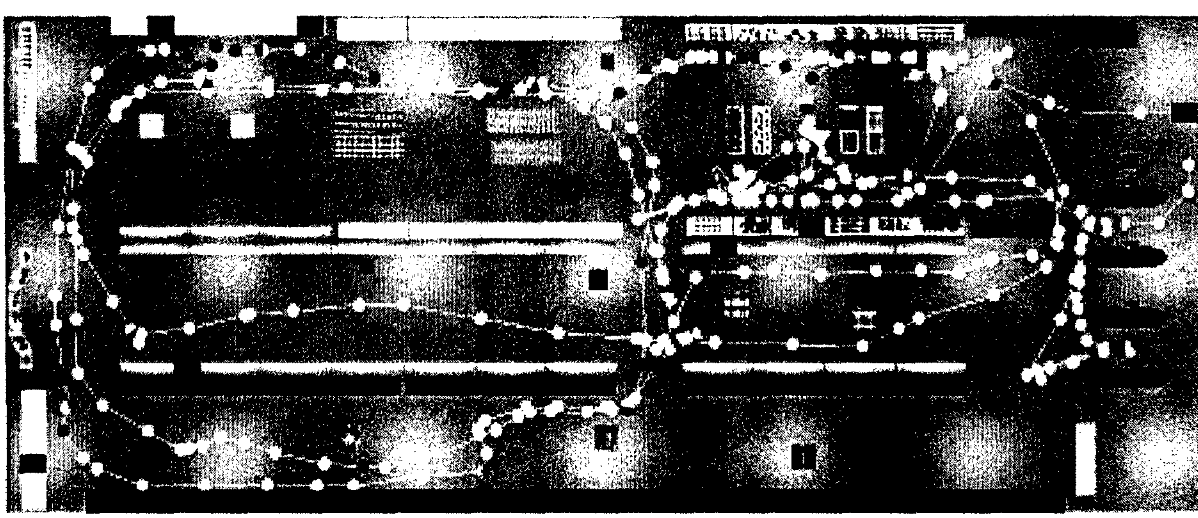

Figure 4: Trajectory of a PD Patient

solutions contrasts with the severe impairment observed in these patients on other "frontal lobe" tests, and may suggest that planning deficits remain undetected if the task employed is insufficiently challenging for these patients[34]. These results underline the usefulness and the difficulties of an adequate evaluation of planning.

Our data suggests partially altered planning functions and provides further understanding concerning the mechanism of this deficit. The absence of significant difference with regard to control subjects for the number of correct actions suggests that global access to the semantic knowledge of the script is normal in PD. However, in our study, the introduction of specific measures such as, distance, duration, number of stops (see Table 1) as well as the trajectory record allow us to precisely identify the planning alteration in PD. Godbout et. al. tried to precisely identify these mechanisms using a script generation test. It was found that the patients with PD generate less sub-orderly actions, "minor actions," than super-orderly actions, "major actions"; the patients would have difficulties recalling contextual elements and consequently their representations of routine activities would not be as rich and detailed as those of controls. Such difficulties could reflect a SAS (Supervisory Attentional System) deficit[8] which modulates cognitive operations. The increased distance and duration, as well as the inefficient trajectory (see Figure 4) observed in our PD group, are consistent with a slowness of information treatment and with the insufficient use of contextual elements[40]. These results underline spatial and temporal aspects of the planning deficits in PD. The trajectory utilized by the patients could also suggest a dysfunction in the switching mechanism necessary to treat in parallel several items of information. Our future analyses using correlations with classical executive tests could help to interpret our results.

From a more general point of view this kind of VE seems to be a useful tool for planning evaluation and rehabilitation. Several teams have already underlined the advantages of this technique, in particular its ability to evaluate the executive functions and attention properties[-36]. One of the specific interests of our VE, compared with previous studies, is the strict similarity to the real word. In fact, we took into account the real dimensions of a supermarket, we reproduced the various shelves, and unlike other studies, the subjects can move freely in the supermarket. Finally, our principal target population, PD, is characterized by a dysfunction in motor symptoms, and VR describes the alterations of planning by utilizing a non-clinical point of view, by testing "pure" mental sequences without the interference of motor disability.

6. CONCLUSION

In accordance with our experience in action planning, and our dissatisfaction with the current tools of evaluation, we decided to design a 3D-supermarket to assess action planning for patients suffering from PD. As with many applications in behavioral neuroscience, we designed a controlled environment that is as life-like as possible. We defined the requirements, the patient tasks and the assessment tools. Our data suggests a slowing down of planning processes in PD as well as an inefficient use of contextual elements; however, these results must be confirmed on a larger group. Furthermore, the criteria of success will be constituted by the following additional points: the facilitated use by the subjects and the adaptability of the software, sensibility superior to that of the usual cognitive tools, improvement of the cognitive deficits after training.

ACKNOWLEDGMENTS

This work was supported by a grant PHRC, from the French Ministère de la Santé, Paris. We want to acknowledge Professor Régis Carin (Director of GREYC, Caen) for his administrative and financial support, and Professor Marinette Revenu (GREYC-ENSICAEN) for her technical support. We thank Professor Gilles Defer for the possibility to develop this technique in the Neurology Department.

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Virtual Reality-Enhanced Physical Therapy System

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Abstract: *Joint disease is a significant health issue for a large portion of the general population and an even greater issue for the elderly. Pain associated with joint disease can be treated with pharmacological and non-pharmacological therapies. Currently, there are no pharmacological agents that are able to simultaneously provide relief from the pain, improve quality of life, and not risk adverse side effects.*

The specific aim of this project is to develop a non-pharmacological treatment option for chronic joint pain. We are working to achieve this aim by developing a system that combines virtual reality technology with hardware for physical therapy. Physical therapy (PT) has been shown to be an effective treatment for chronic joint pain, resulting in increased range-of-motion (ROM), greater strength, less dependence on pharmacological treatments, and improved quality of life. Virtual reality (VR) has been shown to distract patients from pain during treatment and therapy. By combining VR with a PT system, we expect to achieve more effective treatments with less discomfort in patients suffering from chronic joint pain.

The results of our pilot study affirmatively confirmed our hypotheses. Of the eight subjects with adhesive capsulitis tested, all of those that were immersed in the virtual reality system were distracted from pain associated with the therapy. Of all of the test subjects, 87.5% preferred using the VR-enhanced system and would have chosen to continue using the VR-enhanced system (if that were possible) in their continued physical therapy treatments.

1. INTRODUCTION

1.1 Joint Pain is a Significant Health Issue

Joint pain is a leading cause of disability and, as our population ages, it will increasingly affect larger numbers of individuals and our national economy. Aging gradually reduces the physiologic reserve that is available to perform daily activities. When the physical impairments and chronic pain associated with joint pain (such as arthritis or adhesive capsulitis) are combined with age-related changes, physiologic reserve is further compromised, which increases the risk of functional dependency and greater economic losses. Patients with joint disease commonly first consult a physician because of pain.

Adhesive capsulitis (AC) affects approximately two percent of the general population. It is characterized by the loss of shoulder motion. Primary adhesive capsulitis is characterized by idiopathic, progressive, and the painful loss of shoulder motion. The onset of pain causes many patients to limit the use of the arm. Due to the loss of motion, patients can gradually find it increasingly difficult to perform everyday activities. AC patients also tend to develop pain compensating movements which, over time, result in less shoulder pain but with the side effects of a stiff shoulder and a significant limitation of function.

The root cause of AC is still not fully understood; however, there are two primary explanations for the underlying pathophysiology of the

disease. There is disagreement as to whether the underlying pathologic process is an inflammatory or fibrosing condition. There is significant evidence that the underlying pathologic changes are due to synovial inflammation and subsequent reactive capsular fibrosis. However, the initial trigger of inflammation and fibrosis is still unknown for most patients.

1.2 Pharmacological Treatments for Joint Pain

The primary goals of treating patients with joint pain are: pain management, minimizing disability, improving quality of life, and preventing progression of the disease. Of these goals, the most important is pain control, because pain has strong associations with disability and quality of life. Furthermore, since there are no causative treatments for joint pain, all therapeutic measures in joint pain treatment are designed to treat symptoms of the diseases (i.e. managing the pain).

The use of drugs for the treatment of pain associated with joint disease has significant drawbacks. For example: analgesics can cause strong adverse reactions and dependency;[4] NSAIDs introduce significant gastrointestinal and renal toxicity; corticosteroids can cause cataracts, a vascular necrosis of bone, osteoporosis, thin skin, and muscle fiber atrophy; and immunosuppressive drugs may result in respiratory compromise, weakness, cognitive deficit, fatigue, sexual problems, and impaired balance.[7] Clearly, there is no single drug that is both completely effective and safe in treating joint pain. Further, the significant risks from prolonged drug use have required the development of non-pharmacological treatments for joint pain.

1.3 Non-Pharmacological Treatments for Joint Pain

Significant effort has been expended in the development of non-pharmacological joint pain treatments. These include: heat, cold, electrical stimulation, light therapy, splints and orthoses, diet, weight loss, psychology, and exercise. Of all of the non-pharmacological pain treatments for joint pain, exercise has been one of the most rigorously studied and shown to have significant beneficial effects for the disease. The proven benefits include: increases in strength, range-of-motion (ROM), aerobic capacity; and decreases in disease activity and pain level.[7]

In AC, a supervised physical therapy program has been used effectively in many patients. Physical therapy is preferred because a major objective in treating AC patients is to restore function by decreasing the inflammation and pain, increasing ROM, and reestablishing normal shoulder mechanics. Research has shown that there are significant long-term benefits to physical therapy for AC patients. It has been observed that passive ROM increased significantly for flexion, abduction, and internal and external rotation of the shoulder. The physical therapy also resulted in significant decreases in perceived pain between initial and final evaluations. A recent study showed the benefits of using anesthesia during physical therapy treatments for AC. The anesthesia enabled the patients to be distracted from the pain during therapy and enabled the anesthesized group to achieve greater benefits in shorter periods of time as compared to the group receiving the same physical therapy, except without anesthesia.

1.4 Virtual Reality Has Been Shown to Reduce Perceived Pain During Therapy

It has been recognized for some time now that virtual reality (VR) has the potential to be used to improve the quality of life in the real world. Applications include treatment of phobias, eating disorders, post traumatic stress, and pain management. VR allows individuals to become active participants in a computer-generated world that changes in a natural way (i.e. as our past physical experience would suggest) and responds to the individual's motion.

One example of this has been a system developed to distract burn patients from pain during wound care. The system that was developed in these studies consisted of a virtual kitchen where patients could open drawers, pick up pots, touch other objects, and see three-dimensional images. In both reports, the conclusion is that VR can function as an effective non-pharmacological method for reducing perceived pain during wound care and during physical therapy.

Based on the evidence in the open literature discussed above: (1) joint pain is a significant health care issue; (2) an effective nonpharmacological treatment for many of the symptoms of joint pain from a number of diseases is physical therapy; and (3) VR can be used to distract patients during painful therapy, Creare is developing a VR system for physical therapy that can be used to treat joint pain.

2.0 MATERIALS AND METHODS

2.1 System Overview

Figure 1 shows a picture of Creare's Virtual Reality-Enhanced Physical Therapy System. Our system combines an immersive VR system with physical therapy hardware. The system is designed to enable patients with joint pain to undergo rigorous physical therapy treatments while being distracted by VR technology from pain that may be induced by the therapy. Our overall system consists of the following components:

Haptic Interface. The haptic interface is used to both perform physical therapy on patients and to provide realistic force feedback for enhanced immersion in the VR system. Previous research has shown that physical therapy is one of the most effective nonpharmacological treatments for joint disease[7] and that haptic interfaces greatly improve the immersion of VR systems. Our design for treating adhesive capsulitis is built around commercially-available devices originally developed for the computer gaming industry.

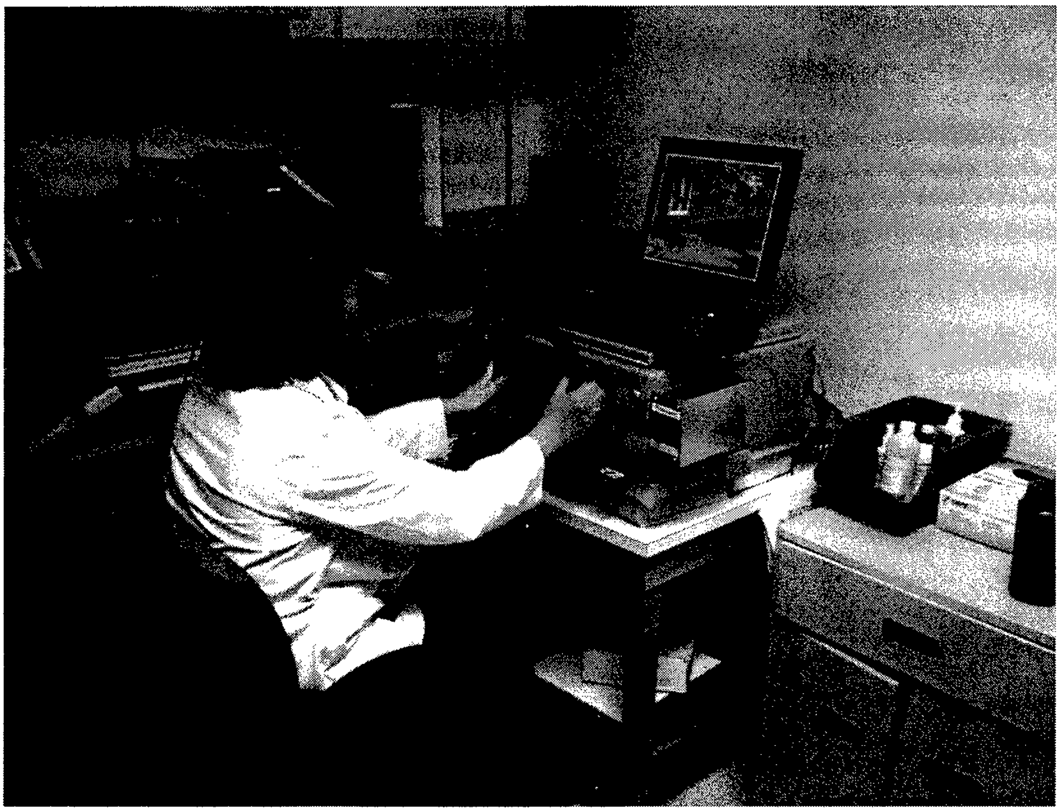

Figure 1: Creare's Virtual Reality-Enhanced Physical Therapy System. Creare's VR-enhanced PT system combines immersive VR technologies with physical therapy hardware. The immersive VR technology is used to distract patients from pain experienced during physical therapy treatments. By distracting patients from pain, the Creare system holds the promise of allowing patients to either tolerate existing therapy procedures better or to enhance the provided therapy. Long term, it is reasonable to expect that the likely result will be less chronic pain and improved clinical outcomes for patients with joint pain/disease.

Visual Display. To provide a greater level of realism in the VR system, we employ a head-mounted display (HMD) which presents the visual content to the user. By using an HMD, we try to fully immerse the user into the VR environment. We make use of off-the-shelf HMD hardware and use graphic rendering software that we have previously developed for a VR training application to render the graphic content to the user. This software makes use of 3D Linx, a commercial off-the-shelf product for real-time display of visual content in games and training systems.

Head Tracker. The system is designed to enable the user to wear an electromagnetic tracker mounted to the HMD. The measurement of head motion is used to compensate in real time for motion parallax and other display anomalies common in virtual reality visual displays. In addition, we can make use of the head tracker measurements to present audio information to the user with proper three-dimensional sound content.

Computation Engine. The computation engine consists of hardware for real-time implementation of the signal processing algorithms. The hardware consists of off-the-shelf computer hardware. The inputs to the computation engine are the measurement of the haptic display input, the head tracker device, and the physics-based models used to determine the behavior of the virtual environment. The output from the computation engine includes the visual, auditory, and haptic displays. We have previously developed real-time software for proper timing and for analog-to-digital and digital-to-analog conversion while making use of off-the-shelf computer hardware that was modified for this application.

Underlying Software. The VR-enhanced physical therapy system is designed around a module architecture that permits each component of the system to be modified without affecting overall operation of the system. This approach facilitates incorporating new hardware, VR content, physics-based mod-

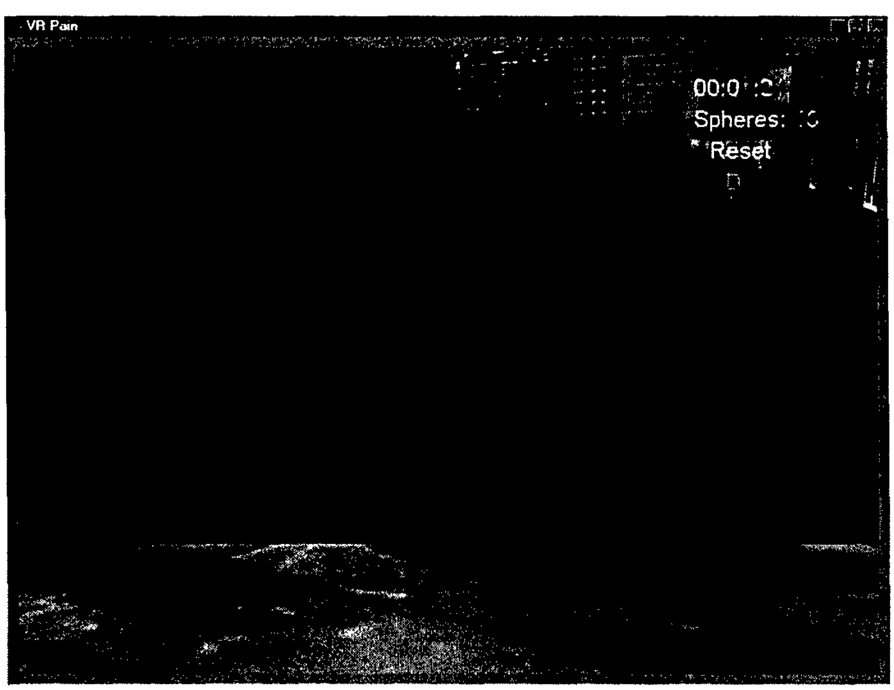

Figure 2: View of Graphical Content for Virtual Reality System. This figure shows the virtual city and landscape that is used for the virtual reality system. The purple balloons are used to define a path for the user to follow with the virtual vehicle and the steering wheel is used to resist movement by the user.

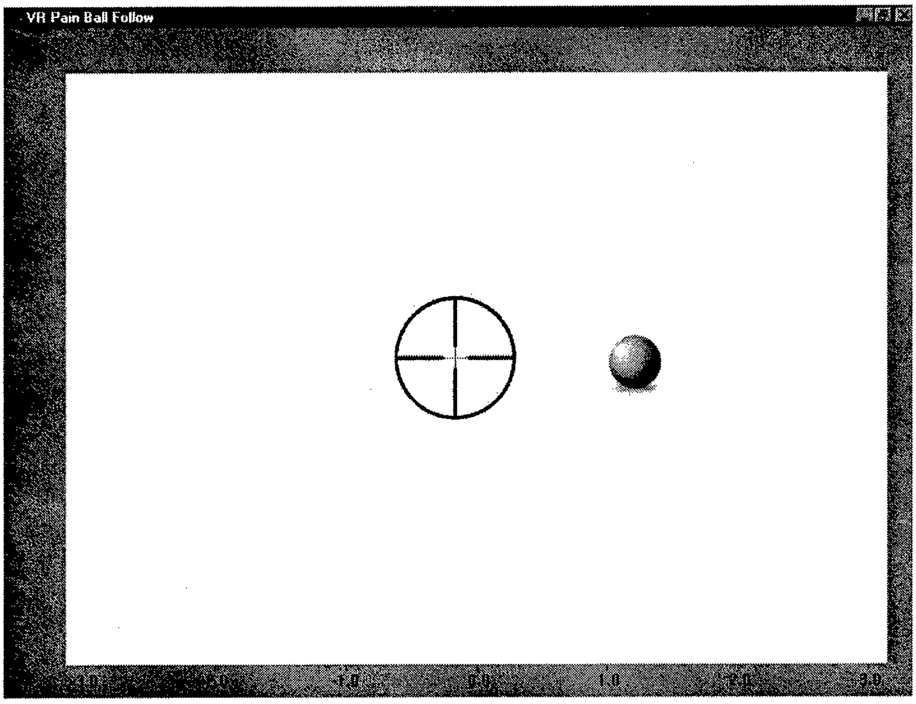

Figure 3. Image of the Non-Enhanced System Screen. This figure shows that the non-enhanced task was to move a crosshair using the steering wheel to follow a round ball as it moved on the screen. Torque is applied to the steering wheel while the user moves the wheel.

els, and physical therapy routines. This design allows our system to be easily modified for new and more challenging applications in chronic pain management that might require specific physical therapy routines or procedures.

2.2 VR Graphical Content

The graphical content of the original training system upon which our system is based consisted of city and country roads over which the patient could drive (shown in Figure 2), all the while feeling the interaction of the vehicle with the road and viewing the motion of the vehicle relative to the surrounding environment. The new design adds a well-defined task to the system and makes use of the existing graphical content. We added a "game" to the system such that the driver has a fixed amount of time to drive over markers placed on a number of the roads and part of the countryside. Each marker that is driven over is counted and the patient achieves a score based on the number of markers "collected" (much like the old Pac Man video game).

2.3 Non-Enhanced System

In order to provide a method for direct comparison between our VR-enhanced physical therapy system and a non-enhanced system, we developed a non-enhanced system using the same hardware as the enhanced system. For this system, the task was to follow a moving round target by rotating the steering wheel to move a crosshair. A picture of the screen for the non-enhanced implementation is shown in Figure 3. While the user rotates the steering wheel, the wheel also applied torque so that the user is forced to apply retarding torque and, thereby, exercise their shoulder muscles. The target position and torque applied to the steering wheel are "played back" from a data file which contains a time history of target positions and torque values. The data files can be recorded from previous interactions with the hardware, either during a familiarization session or during a VR-enhanced session.

3.0 RESULTS

Using the system described above, we performed a pilot human subject test designed to

Subject	Sex	Age	Pain during non-VR	System to use in future	Immersion	Slope (torque/angle)
1	F	76	a little more	VR-enhanced	moderate	-0.024
2	F	53	more	VR-enhanced	high	-0.074
3	M	78	much more	VR-enhanced	moderate	-0.155
4	F	75	less	VR-enhanced	low	-0.286
5	M	69	less	Non-enhanced	low	-0.350
6	F	53	same	VR-enhanced	moderate	-0.096
7	F	56	a little more	VR-enhanced	high	-0.096
8	M	58	a little more	VR-enhanced	high	-0.162

Table 1: Summary of Pilot Human Subject Test Results

investigate the following hypothesis: An immersive VR system can be used to distract patients suffering from joint disease from pain during physical therapy treatment.

We performed the pilot human subject test at the Massachusetts General Hospital Physical Therapy Clinic with eight test volunteers. Dr. Michael Kane of the Massachusetts Institute of Technology performed the diagnosis of adhesive capsulitis, recruited all of the subjects and obtained informed consent documents prior to their first visit to the PT clinic. Once at the PT clinic, Ms. Katherine Breen, PT, DPT, performed a standard initial PT exam for all of the patients and reviewed the human subject test protocol. Afterwards, the volunteers were brought to the area where the hardware was set up and the testing began, following the approved protocol. All of the test results are summarized in Table 1. The table shows the sex and age of the subject, the subject's responses to the questions that we asked, our qualitative assessment of level of immersion (based on the length of time required to familiarize with the hardware and score on achieving the goals of the task), and the calculated slope of the torque vs. angle curve generated by recording the data during the VR-enhanced session.

The test subjects ranged in age from 53 to 78, with four between the ages of 53 and 58 and four between the ages of 69 and 78. The test subject population consisted of five females and three males, two of the males were in the 69–78 age group.

3.1 Pain Perception

Overall, five of the eight participants ranked the relative level of pain experienced during the non VR-enhanced session as being greater than the pain experienced during the VR-enhanced session. Of the five, three ranked the pain as "a little more pain," one ranked the pain as "more pain," and one ranked the pain as "much more pain." One test subject ranked the pain as being the same between the two systems, and two participants ranked the pain as being less during the non VR-enhanced session.

3.2 Affective Results

Seven of the eight participants found the VR-enhanced session to be more pleasurable, preferred to use the VR-enhanced system, and would choose to use the VR-enhanced system for continued therapy if that were possible. The one individual who found the non VR-enhanced session to be more pleasurable also found the non VR-enhanced session to generate less pain. This individual also complained of a headache that may have occurred because the HMD was likely not adjusted properly (it was too tight and he did not say anything until the session was over). We believe that this issue with the HMD also contributed to this participant's lack of immersion in the VR environment.

4.0 DISCUSSION

The results of our pilot study, clearly demonstrated the feasibility of our VR system. We achieved our research objectives by developing an early prototype VR-enhanced physical therapy system for frozen shoulder; performed a pilot human subject test of the system; and developed the design of a clinical system appropriate for use in long-term studies. Our test results confirm that VR-enhancement has the potential to distract individuals from pain during therapy, that patients enjoy using VR-enhanced hardware, and that patients would like to continue to use a VR-enhanced system if that were possible.

The test subject who ranked the pain as the same used the VR-enhanced system second and may have suffered a bit from fatigue due to the buildup of exercise from the intake exam and first non VR-enhanced therapy session. This subject spontaneously said "This works, I am not even thinking about my shoulder" during the VR-enhanced session. This comment indicates that the VR-enhanced system was performing as expected, even though the response to the specific question regarding pain does not clearly support our hypothesis.

Neither of the participants who ranked the relative level of pain in the non VR-enhanced session as less were completely immersed in the VR-enhanced system. Both of these participants were from the 69–78 age group and had a difficult time keeping the virtual vehicle near the path defined by the task. In retrospect, we could have recorded the number of balloons on the path that were "collected" by the participant and used this as an indication of immersion. The two subjects who experienced more pain obtained very low scores on the task as defined by "collection" of the balloons; whereas all those who scored well on the given task, reported more pain experienced during the non VR-enhanced session.

Further, the data recorded during the VR-enhanced sessions for these two individuals showed a very high slope of torque vs. steering wheel angle; almost twice as high as the next highest values. This slope is an indication of the "gain" of the force feedback or spring constant. This indicates that these subjects had to work very hard to move the steering wheel against a relatively large resistive force. This came about because both individuals were not able to control the speed of the virtual vehicle and kept it moving at a relatively high speed through the environment. This had the dual effect of making them score poorly on the task as well as increasing the level of work that they needed to perform during the session. Figure 4 shows a graph of the torque vs. angle data for Subjects #1 and #5. These data show the quantitative difference between the interaction that the subjects had with the system during the VR-enhanced session. Effectively, the data in Fig-

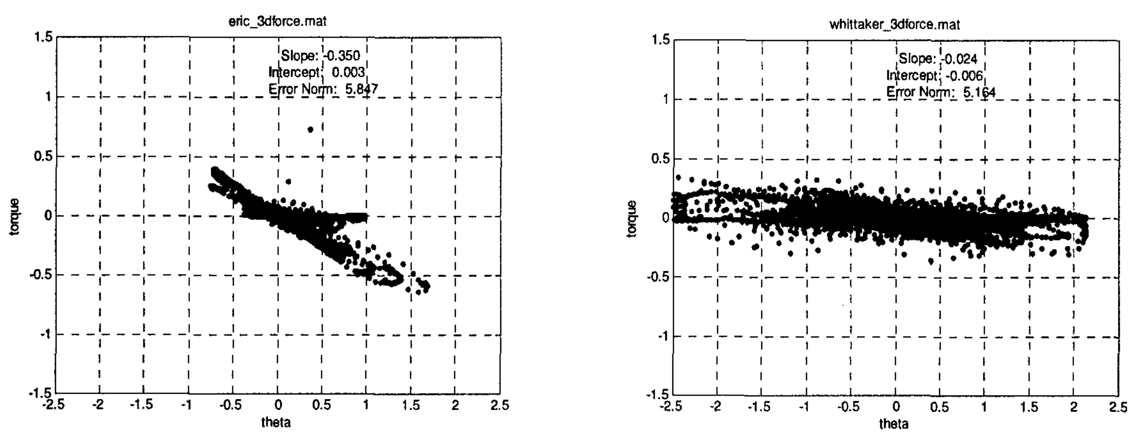

Figure 4: Torque vs. Angle Data Recorded During Two VR-Enhanced Sessions. (a) shows data from Subject 5 whose effective steering wheel resistance was large compared to other subjects. (b) shows data from Subject 1 whose steering wheel resistance was comparable to most of the other subjects.

ure 4a show that the steering wheel resistance is much greater than that shown in Figure 4b, resulting in greater effort being expended by the participant and the greater feeling of pain during the VR-enhanced session.

We also noticed that the individuals in the 69–78 group were on average less familiar with computer technology (especially games) and required more familiarization time with the hardware than the individuals from the 53–58 group. Our evidence suggests that people who were more familiar with the hardware and computers were more likely to become immersed in the VR and were much more likely to be distracted from the pain.

5.0 ACKNOWLEDGEMENTS

The authors would like to acknowledge the support of this effort by Dr. Ro Nemeth-Coslett of the National Institute of Health, National Institute on Drug Abuse and SBIR grant no. NIH/N43DA-2-7709.

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Robotic Toolkit for Pediatric Rehabilitation, Assessment and Monitoring

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Abstract: *Children with disabilities receive various types of rehabilitation therapies, including physical, occupational, and speech/language therapy. The CosmoBot™ system is a robotic toolkit designed to motivate and monitor children with developmental disabilities, aiding them in therapy, education, and general developmental progress. This patented technology includes CosmoBot™, an interactive robot toy, and Mission Control, an adaptive control interface. CosmoBot™ is a child-friendly robot that moves and talks while controlled by a user. Mission Control is a multimodal interface that allows a user to control CosmoBot™ using gestures and voice. The CosmoBot™ system targets therapeutic and educational goals while allowing children to engage in a play activity. A feasibility study was conducted to evaluate the effectiveness of the CosmoBot™ system for combined occupational and speech/language therapy. Based on qualitative data consisting of feedback from the therapists and parents of the children participating in the study and observations made by the engineering design team, the CosmoBot™ system was found to be a useful motivational tool, targeting a number of therapeutic and educational goals.*

1. INTRODUCTION

Children with developmental disabilities often must perform a variety of therapeutic exercises during and between therapy sessions to strengthen muscles, increase range of motion or vocabulary, and address basic developmental goals. While necessary for achieving developmental goals, such exercises can be tedious, fatiguing, and sometimes even painful. In addition, there are currently few objective methods for obtaining outcome measurements of a child's therapeutic progress while performing the prescribed exercises. Therefore, a need exists for a tool that provides both motivation and embedded assessment capabilities for therapeutic and educational applications.

Studies have shown that when children are engaged in a purposeful activity, such as play, they are intrinsically motivated and actively engaged, yielding better results, in some cases, than those achieved using rote exercise. One such study, conducted by Sakemiller and Nelson, found that embedding exercise within a play occupation enhanced the prone extension of two children with hypotonic cerebral palsy. AnthroTronix, a human factors and rehabilitation engineering company, has designed a technology tool to target developmental goals within a play environment.

2. DESIGN AND DEVELOPMENT

All rehabilitation technologies developed by AnthroTronix are designed via a user-centered model. This user-centered design process draws on input from the end users via focus groups, formal and informal interviews, and system evaluations at each step in the design process (Figure 1). This method of design results in user-defined specifications, as opposed to engineer-defined specifications. The end users define needs to be met by the technology. Requirements, capable of meeting the specified needs, are then generated by the design team. The users continually provide feedback to the design team throughout the development of the concept design, the detailed specifications, and the resulting prototype. The prototype is then evaluated by users in a therapy or educational setting, leading to product development as well as additional needs for subsequent design iterations.

A list of needs was identified by the end users, in this case children with disabilities and their therapists, teachers, and parents. The needs identified were that the technology must 1) provide motivation, 2) provide empowerment, 3) be applicable across therapy domains, 4) accommodate a variety users, 5) provide long-term motivation, 6) be easy to use, 7) provide objec-

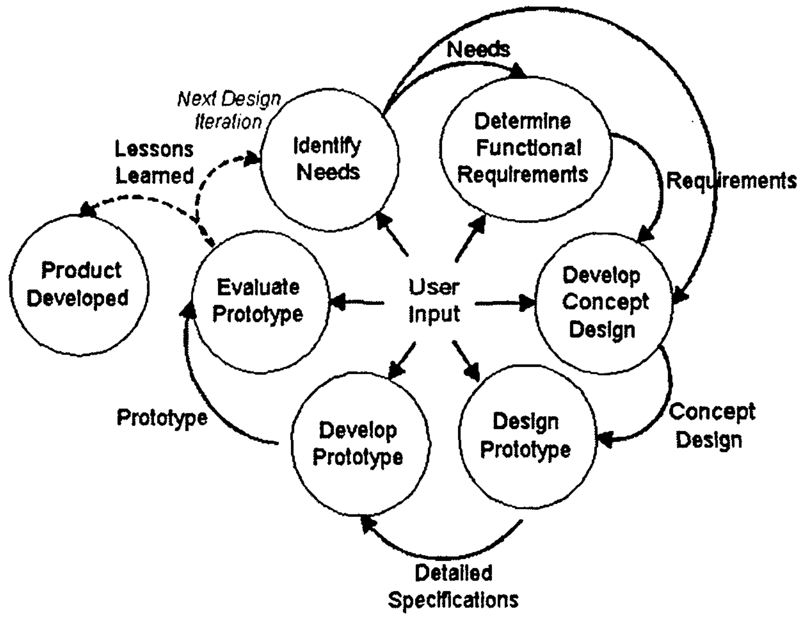

Figure 1: User Centered Design Model

tive measures of progress, and 8) be applicable for both on-site and remote therapy. From these needs, requirements were defined (Figure 2).

As previously identified, a primary need (1) defined by both therapists and researchers is motivation. The requirement identified for the technology to meet this need was the provision of a play environment, implicating that the technology must involve some type of game or toy. The second need (2), that the therapeutic activities provide empowerment is met by enabling children to control their environment. This provides children with a sense of independence and accomplishment and prevents the activity from being passive. In addition, this sense of control combats "learned helplessness", the condition in which children become passive and learn to depend on others to interact with their environment. The third need (3) was that the technology must be applicable across therapy and educational domains, including physical, occupational, speech-language, and behavioral therapies, as well as special education. The associated requirement, defined by the therapy

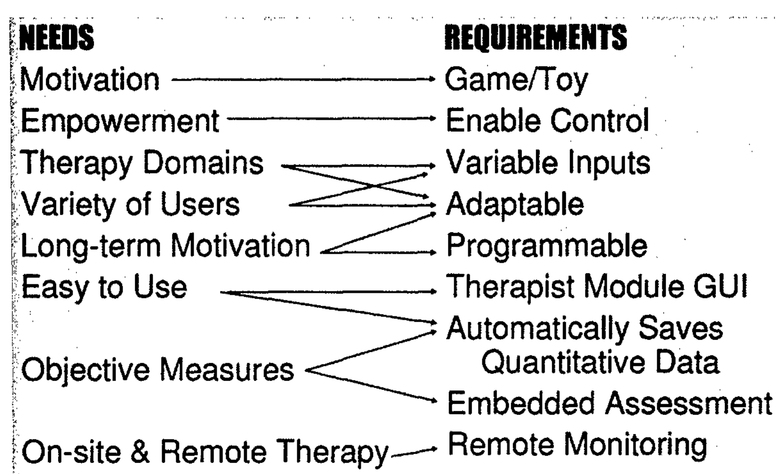

Figure 2: Derivation of Requirements from User-Defined Needs

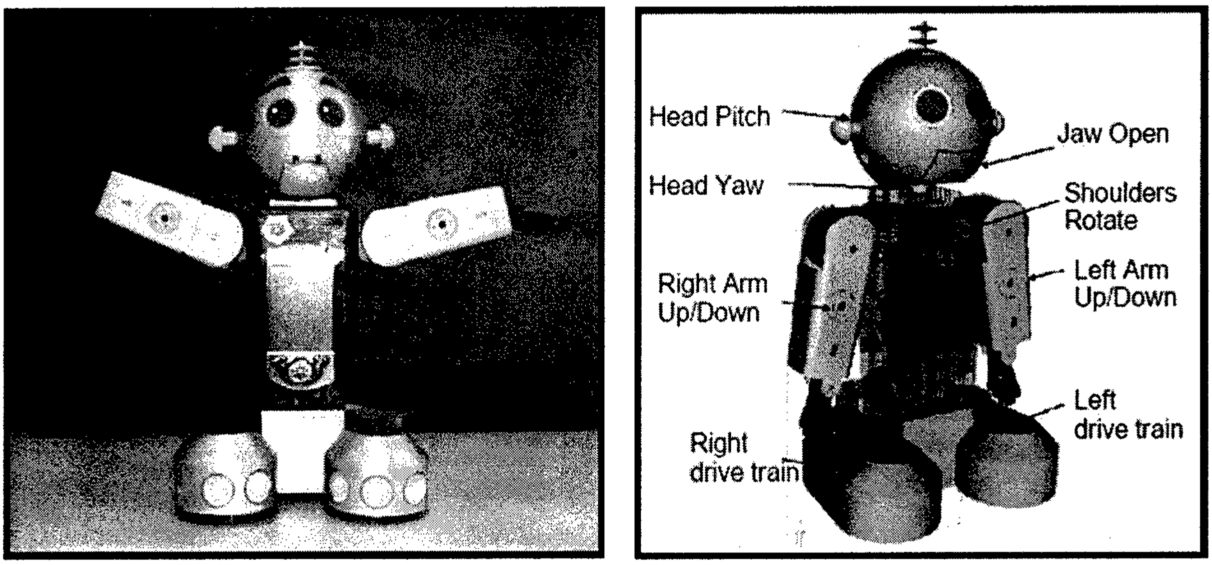

Figure 3: CosmoBot™'s wheels can move forward, backward, left and right, its arms move up and down and together and apart, and its head can move up and down ("yes"), left and right ("no"), and any combination of the two.

and design team, was that the technology must have variable inputs and be adaptable. As defined by the fourth need (4), the technology must be designed to meet the needs of a variety of users with varying types and degrees of disabilities. In this case the requirement was defined as the adaptability of the technology, as well as programmability. This last need of programmability, is also associated with the fifth need (5), which is long-term motivation. It is important that the technology not lose effectiveness. By making the technology programmable, it can effectively meet the specific needs of individual users, and continue to meet their changing needs over time. An important requirement for all technologies, as identified by the sixth need (6), is ease of use. In order for successful technology transfer to take place, the tech must be easy to use by the child, as well as the child's therapists, teachers, and family members. The design team, therefore identified the requirement of a graphical user interface to allow the users to easily adjust settings and view data. Therapists also identified the need (7) for the provision of objective measures for assessment and monitoring of therapeutic progress. This supports the requirement for embedded assessment software, which will automatically save quantitative data. Finally, in order to meet the need (8) for both on-site and remote therapy, a final requirement was identified: that the technology include remote monitoring capabilities.

The defined needs and requirements led to our initial concept design, CosmoBot™, a child-friendly robot that moves and talks while controlled by a user (Figure 3). CosmoBot™ was developed as part of a robotic toolkit system to motivate and monitor children in physical, occupational, and speech/language therapy. The toolkit includes CosmoBot™ and Mission Control, an adaptive control interface.

The robot, shown in Figure 3, contains 6 servos, controlling head, arm, and mouth movements, as well as 2 DC motors driving a set of wheels under its feet. The robot also contains an analog to a digital (A/D) board and a handheld computer for receiving commands. The handheld computer allows the robot to be programmed in a variety of ways to meet various therapeutic and educational goals. By giving children control over the robot's movements and speech they are empowered with a sense of environmental control. The robot was designed to be child-friendly, as well as hygienic, for use in schools and clinics. It allows for a variety of control inputs, including speech and gestures.

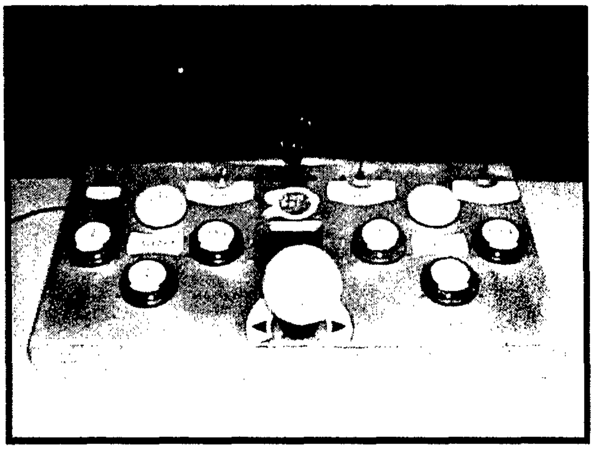

Figure 4: Mission Control is an adaptive interface that allows children to control CosmoBot™ using movements and speech.

Mission Control is a multimodal interface which provides wireless control of CosmoBot™ over TCP/IP. Like the robot, this adaptable control interface contains a handheld computer, which can be programmed to map control of the robot's movements to a variety of inputs, including gestures and voice (Figure 4). Gestures may include reaching for a button, operating a joystick, or activating wearable sensors through body movement. Voice control is enabled through voice recognition software, allowing control of CosmoBot™ by speaking into the microphone.

The wearable, gestural sensors plug into Mission Control, and allow the child's movements to be mapped onto those of the robot. Figure 4 demonstrates one such sensor: Here the child is wearing an armband, which contains an accelerometer. A threshold is set in the Mission Control software and mapped to the robot's arm movements, so that when the child raises his arm, the robot mimics this movement. The system can be configured to correspond to a variety of therapy exercises by altering the positioning of the sensors on the body and the threshold of activation set in the software, thereby targeting various muscle movements, and therapeutic goals across domains. The sensors themselves are designed to be comfortable, adjustable, and hygienic for use in an educational or clinical setting.

The novelty of this innovation is in the versatility of the technology, as well as its ability to target developmental goals across therapeutic domains. While many tools exist for meeting specific therapy and educational goals, there are few that can be applied across physical, occupational, and speech/language therapies, as well as general developmental goals. Additionally, the range of interface options allows this system to be useful for a variety of age and disability groups.

3. METHODS OF EVALUATION

The CosmoBot™ system was evaluated by the end users, in this case children with disabilities, and their parents, therapists, and teachers. The objectives of this evaluation were to identify and address problems with the technology, and to evaluate its usability in a therapy setting. In order to do this, we conducted a research study in a combined SLP and OT setting, as well as conducting several focus groups involving a variety of professionals working with children with disabilities. The feasibility study was funded by a National Science Foundation Phase I SBIR. It took place at Claremont Academy in Arlington, Virginia, where three children participating in combined occupational and speech/language therapy, and their therapists, used the system during individualized therapy sessions over a ten-week period. Prior to introducing the technology, three baseline therapy sessions were conducted without the use of the

Figure 5: A Gestural sensor is used to control CosmoBot™'s arm movements

technology, informing the design team as to the practices and therapeutic interventions employed during a typical therapy session. Subjects were recruited based on the following criteria: 1) attending weekly occupational and speech therapy sessions, 2) having a developmental age of 2 or more, and 3) parental consent. Based on these criteria, the following subjects were recruited by the therapists: Subject 1) a 5-year-old Latin American male diagnosed with Down Syndrome, Subject 2) an 8-year-old African American male with global developmental delays, and Subject 3) a 6-year-old Caucasian/African American male diagnosed with autism. Data were collected in the form of therapist and parent interviews, video, and notes and observations taken by the participating therapists and the design team. Qualitative methods informed us throughout the study of problems and successes in CosmoBot™'s usability, as well as general and specific responses to CosmoBot™ by participants. Each session was videotaped. Therapists and an observer used a questionnaire to record data. A second observer not affiliated with the study took data on every third session. Questionnaires covered therapeutic approaches used and adjustments needed, speech/language and occupational therapy goals addressed, participant responses to the technology, and compatibility of the technology with treatment.

4. RESULTS

Based on the feedback from the therapists and parents of the children in the study, as well as observations made by the engineering design team, the CosmoBot™ system was determined to be a useful motivational tool, targeting a number of therapeutic and educational goals. The system was found to be particularly useful for facilitating directed play involving auditory processing, following directions, spatial positioning, matching and associations, and verbalization of associations. CosmoBot™ was also successful in targeting social greetings, eye contact, 2-word utterances, language concepts, auditory processing, word association skills, and coordination and understanding of body positions in space. Individual subject results, as indicated by the therapists, and video observations were as follows:

Figure 6: An occupational therapist and speech-language pathologist use CosmoBot™ to facilitate an integrated therapy session with two of the study participants while a member of the engineering design team observes.

Subject 1 liked the technology and was highly enthusiastic. The technology assisted in enabling him to produce spontaneous and imitative single words. The therapists also noted that from the start, he smiled a lot when in the presence of "Bot". When the therapists were distracted for a minute, he was definitely in charge of "Bot". Subject 2 was highly enthusiastic and especially enjoyed speaking through the microphone. As the sessions progressed, he began to speak more spontaneously, using the microphone as a tool; he seemed empowered by this experience. Additionally, Subject 2 was sensitive to whether or not the technology was working. It was clear that when CosmoBot™ was fully functional, he was more motivated to engage in the session's activities and he displayed more energy. During these sessions there was a smooth transition between activities, an increased number of activities, and consistent attentiveness. Subject 3 was highly enthusiastic; he spontaneously gave verbal commands to "Bot" and also imitated several commands. He enjoyed manipulating the controls, and easily controlled "Bot". It was clear from the video analysis that even when no one else could get this subject focused on a therapeutic activity, CosmoBot™ commanded his attention.

Additional feedback was obtained during several focus groups involving a variety of professionals working in the fields of physical therapy,

occupational therapy, speech/language therapy, and special education. Two such focus groups were conducted at the California State University at Northridge Center on Disability conference in March of 2002 and 2003. An additional focus group was conducted in November of 2002 at Kennedy Krieger School in Maryland, which is a non-public special education facility employing several speech language pathologists. These focus groups provided the basis for prototype evaluation and incorporation of changes for the subsequent design iteration. At each of the three focus groups the participants were asked to identify critical problems or needs of children that might benefit from using CosmoBot™; some examples identified included aiding with pretend play, manipulative play, physical activities within the classroom (e.g. circle time, song leading), direction words, action words, creative play and action learning processes, and concept development. Additional applications identified included modeling use of a switch, data logging to monitor an activity such as hitting a switch or calculating the mean length of utterance (MLU), acting as a receiver of communication to facilitate interaction, aiding in language for movement/ spatial concepts, sequencing, using as a calming effect for sensory integration, and turn taking. The results of the focus groups were particularly helpful in identifying development plans for interventions to meet therapeutic goals and content ideas for future interactive content.

5. DISCUSSION

This study demonstrated the technical feasibility of a robotic toolkit for pediatric rehabilitation in combined occupational and speech/language therapy. Specific therapeutic interventions were identified for each of the functional goals and objectives. From a clinical perspective, CosmoBot™ showed potential to make an impact on the speech and language development of several children while contributing to their motivation for learning. All of the children were highly motivated by the technology and made some progress toward their goals. Feedback from the end users (children with disabilities, families of children with disabilities, and therapists), as well as observations from the engineering and design team, provided the basis for prototype evaluation and incorporation of changes for the subsequent design iteration. Currently, AnthroTronix is manufacturing a second generation prototype for use during clinical testing at two outpatient therapy sites and one school. It is hoped that clinical testing will provide qualitative data supporting this research effort, investigating the effectiveness of the CosmoBot™ system in targeting therapy and educational goals. The clinical testing will use controlled experiment design and data collection methods to obtain objective and concrete data to validate this research. Feedback obtained during clinical testing will also enable us to move toward a commercial product for use by therapists, teachers, and other professionals working with children with disabilities.

6. ACKNOWLEDGEMENTS

The authors would like to thank Dr. Sharon Malley, Carlotta Rodella, and Chris Fleming for their vital contribution to this research effort. We would also like to recognize Jack Vice, Matthew Pettersen, Kris Edwards, and Ara Hacopian for their efforts throughout the design and development process.

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7. National Science Foundation Phase I SBIR grant DMI-0128492

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Robot Therapy at Elderly Institution by Therapeutic Robot

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Abstract: *This paper describes mental commit robots that provide psychological, physiological, and social assistance to human beings through physical interaction. These robots look like real animals such as cats and seals. The seal robot was developed especially for therapy. The seal robots have been applied to assisting the activity of elderly people at a health service facility for the aged. In order to investigate the psychological and social effects of the seal robots on the elderly people, we evaluated the elderly people's moods by face scales (which express a person's moods by illustration of faces) and the Profile of Mood States (which measures a person's moods via questionnaire). Seal robots were provided for the facility for three weeks. Our study shows that the feelings of the elderly people were improved by interaction with the seal robots.*

1. INTRODUCTION

1.1. Aged Society

Due to the improvement of our living environment, dietary life, and medical progress, people are now living longer than they ever have before. According to the United Nations, a ratio of people 65 years old and over against total population of a country exceeding 7% indicates an aging society. A ratio exceeding 14% indicates an aged society. Fig.1 shows change of the ratio of most advanced countries. Now, countries other than the U.S. are aged societies

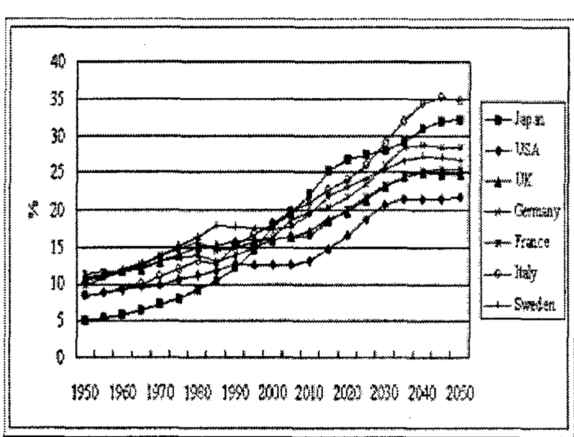


Figure 1: Ratio of people 65 years old and over against total population of most countries

[1]. Moreover, an increasing ratio is predicted for the future. Therefore, the number of elderly people who need nursing because of dementia, disabilities which keep them bedridden, etc., is increasing. There are many people who will stay in an elderly institution for a long time, until the end of their life. Moreover, the body and mental poverty of nursing staffs caused by manpower shortages and increased loads are becoming a big problem. The mental stress of nursing causes Burnout syndrome [2], which causes members of the nursing staff to feel irritated and lose sympathy with patients. Therefore, it is important to improve the quality of life (QOL) of elderly people because this helps them to spend their life healthily and independently. It also saves social costs for elderly people.

1.2. Animal Assisted Therapy and Activity

It has been said for many years that interaction with animals heals the human mind. In recent years, the positive effects of animal/human interaction upon humans has been researched and scientifically proven. Friedmann investigated the one-year survival rate of patients who were discharged from a coronary care unit. The survival rate of people who kept pets was higher than that of those who did not [3]. Baun reported that blood pressure lowered when people were stroking their dogs [4]. Garrity investigated elderly people who were socially isolated

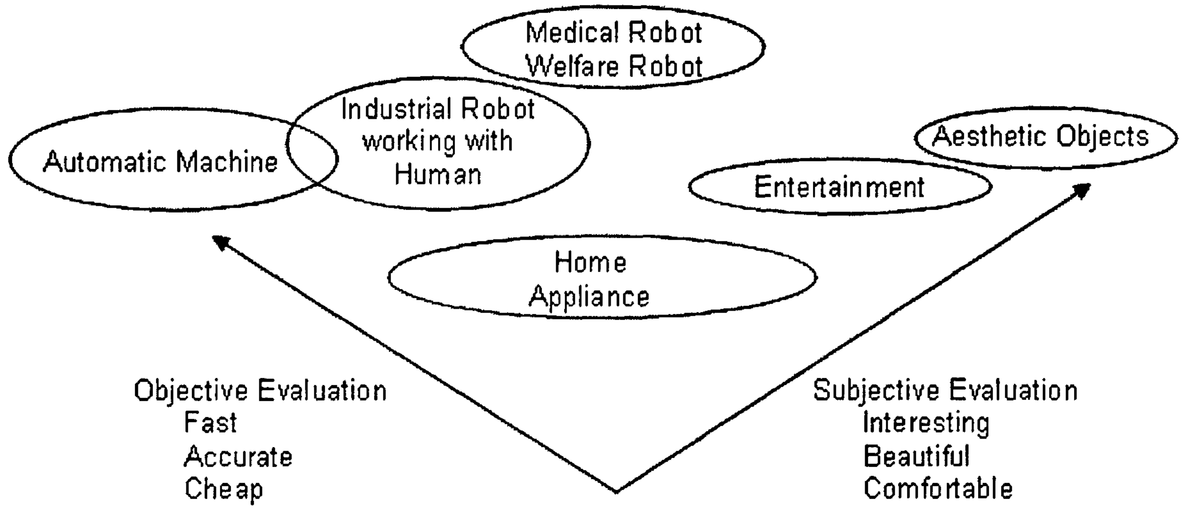


Figure 2: Objective and subjective evaluations classified by application in the design of artificial objects

and had lost their partner within the past year. The morbidity rate of depression of people who did not keep any pets was higher than that of those who kept pets [5].

The effects of animals have also been applied in medical settings. Especially in the United States, animal assisted therapy and activity are becoming prevalent at hospitals and nursing homes. There are clear goals for animal assisted therapy. A doctor, nurse, or social worker makes a program for therapy in cooperation with volunteers. Animal assisted activity also

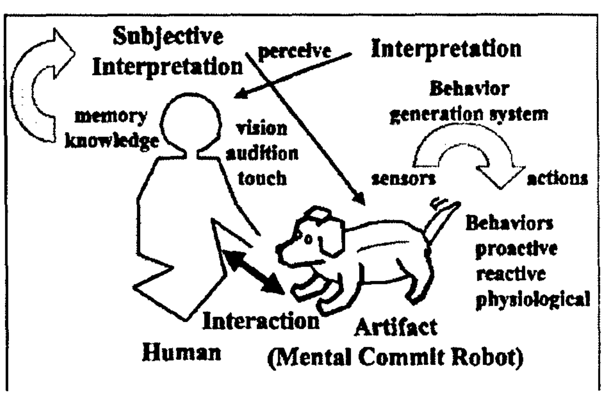


Figure 3: Subjective interpretation through interaction

occurs when patients interact with animals during leisure time, during which attention is not paid to the special goals of the treatments. The activities depend on volunteers. Following are three effects that are expected as a result of animal assisted therapy and activity:

1. Psychological effect (e.g. relaxation, motivation)
2. Physiological effect (e.g. improvement of vital sign)
3. Social effect (e.g. activation of communication among inpatients and caregivers)

In addition to these effects, animal assisted therapy at nursing homes also acts as rehabilitation therapy for elderly people who have decreased in moving ability, and provides an opportunity for laughter and enjoyment to a patient who has few remaining joys in his life [6]. Moreover, there have been cases where the therapy has improved the state of elderly people who had dementia. However, most hospitals and nursing homes, especially in Japan, do not accept animals, even though they admit the positive effects of animal assisted therapy and activity. They are afraid of the possible negative effects of animals such as allergies, bites, and scratches which might cause infection.

1.3. Mental Commit Robot

The field of robotics has been largely used for automation in industrial manufacturing. Most of those are machines optimizing practical systems in terms of objective measures such as accuracy, speed, and cost (Fig.2). Therefore, humans give machines suitable methods, purposes, and goals. Machines are passive tools of humans.

We have been researching different robots from such machines. If a robot were able to generate its own motivation and behave voluntarily, it would be able to influence its interactions with humans. At the same time, the robot would not be a simple tool for human use, nor be evaluated only in terms of objective measures. We have been building animal-type robots as examples of artificial emotional creatures [7-18] since 1993. The animal robots have physical bodies and behave actively while generating goals and motivations by themselves. They interact with human beings physically. People recognize the robots and subjectively interpret their movement based on knowledge and experience (Fig.3).

When we engage physically with an animal-type robot, it stimulates our affection. Then we have positive emotions such as happiness and love, or negative emotions such as anger and fear. Through physical interaction, we develop attachment to the animal robot while evaluating it as intelligent or stupid by our subjective measures. In this research, animal-type robots that produce such mental effects in human beings are referred to as "mental commit robots." We have developed dog and cat robots as familiar animals to humans, and a seal robot as a non-familiar animal.

When people in public evaluated the dog or cat robots, they became severe in their subjective evaluation because they compared the robots with their images of real animals. On the other hand, in the case of seal robot, people accepted it as it was without criticism. Therefore, the seal robot was more acceptable to the public.

1.4. Robot Therapy

The seal robot was improved so it could be applied to therapy at hospitals and elderly institutions. The seal robot had been used in child

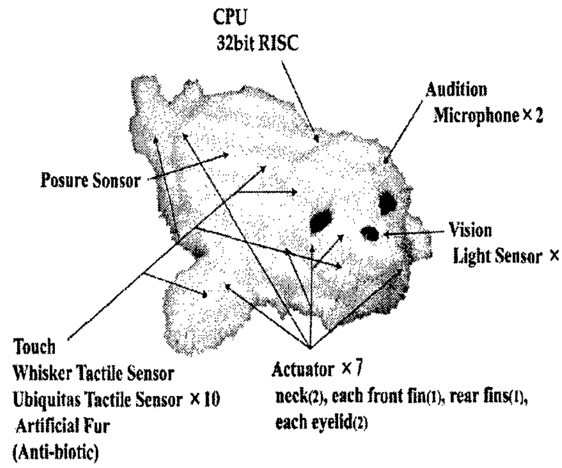


Figure 4: Seal robot "Paro"

therapy at a university hospital for four months in 2000 [14, 15]. This was referred to as robot-assisted therapy (RAT). The moods of the children were improved by interacting with the robot. Moreover, the robot encouraged the children to communicate with each other and their caregivers (Fig.5). In one striking instance, a young autistic patient recovered his appetite and speech abilities during the weeks when the robot was at the hospital. In another case, nurses noted the rehabilitative benefits for a long-term patient, unable to leave her bed, who was willing to stroke and pet the seal robot (Fig.6).

Figure 5: Interaction between inpatient and seal robot, and social interaction between children.

Figure 6: Interaction between child inpatient on bed and seal robot

In addition, we have used seal robots in robot-assisted activity (RAA) for elderly people who visit a day service center [15-18]. The day service center is an institution that aims to decrease the nursing load on the family by taking care of the elderly people during the day.

Fig.7 shows a scene of usual life of elderly people at the day service center. They didn't communicate with each other much, even if a caregiver talked to them and tried to foster communication. The atmosphere of the day center was dark. One of the main reasons for this was a lack of a common conversation topic, as the various people lived unrelated lives.

Figure 7: Scene of usual life of elderly people at a day service center

After Paro's introduction to the elderly people, interaction with the seal robots improved their moods, made them more vigorous, and encouraged them to communicate with each other and their caregivers (Fig.8). Moreover, results of urinary testing showed that interaction with Paro reduced the stress of the elderly. In an interesting instance, an elderly lady who seldom talked with other people became quite communicative towards others when she was interacting with the seal robot. In addition, the seal robot influenced people who had dementia. One example is an elderly lady who did not try to behave independently, and often forgot things that she had just done. When she was interacting with the seal robot, she often laughed and she seemed brighter than usual. Another example is an elderly lady who tended to want to go back home, but who kept staying at the day service center to play with the seal robot, and looked happy. We also investigated the nursing staff's mental distress as a result of taking care of the elderly people. The results showed that their mental distress decreased because the elderly people spent their time by themselves with the seal robots.

Figure 8: Interaction between elderly people and seal robot at a day service center

Furthermore, some animal-type robots (such as Furby, AIBO [19], NeCoRo, etc.) have been commercially released by several companies in recent years. There have been studies conducing RAA with these robots. For example, Yoko-

yama introduced AIBO to a pediatrics word, and observed the interaction between the children and AIBO [20]. He pointed out that the stimulus received from AIBO was effective at the beginning, but its stability was quite weak compared with the living animal. In other words, if we meet AIBO or an animal for the first time, for a while we will be stimulated and move. However, the relaxed effect comes as a result of stroking a dog for a long time is not felt when interacting with AIBO.

In this paper, we applied seal robots to assisting the activity of elderly people at a health service facility for the aged, in order to investigate the psychological and social effects of seal robots on the elderly people who stayed at the facility. We also compared the effects of the seal robot and those of a placebo seal robot that had a less active motion generation program.

Section 2 explains the details of the seal robot and the placebo seal robot that were used for RAA. Section 3 describes ways of providing RAA to elderly people. Chapter 4 explains the effects of RAA. Section 5 discusses current results of RAA and future works. Finally, section 6 concludes this paper.

2. SEAL ROBOT AND PLACEBO SEAL ROBOT

2.1. Specifications of Seal Robot

A seal robot, Paro, was developed for physical interaction with human beings (Fig.4). Paro looks like a baby harp seal, which has white fur for three weeks after its birth. As for perception, Paro has tactile, visual, auditory, and posture sensors beneath its soft, white, artificial fur. In order for Paro to have a soft body, a tactile sensor was developed and implemented. As for action, Paro has seven actuators; two for each eyelid, two for the neck, one for each front fin, and one for the two rear fins. Paro weighs about 3.0 [kg].

Paro has a behavior generation system that consists of two hierarchical layers of processing: proactive and reactive processes (Fig.9). These two layers generate three kinds of behaviors; proactive, reactive, and physiological behaviors:

(1) Proactive Behaviors: Paro has two layers to generate its proactive behaviors: behavior-planning layer and behavior-generation layer.

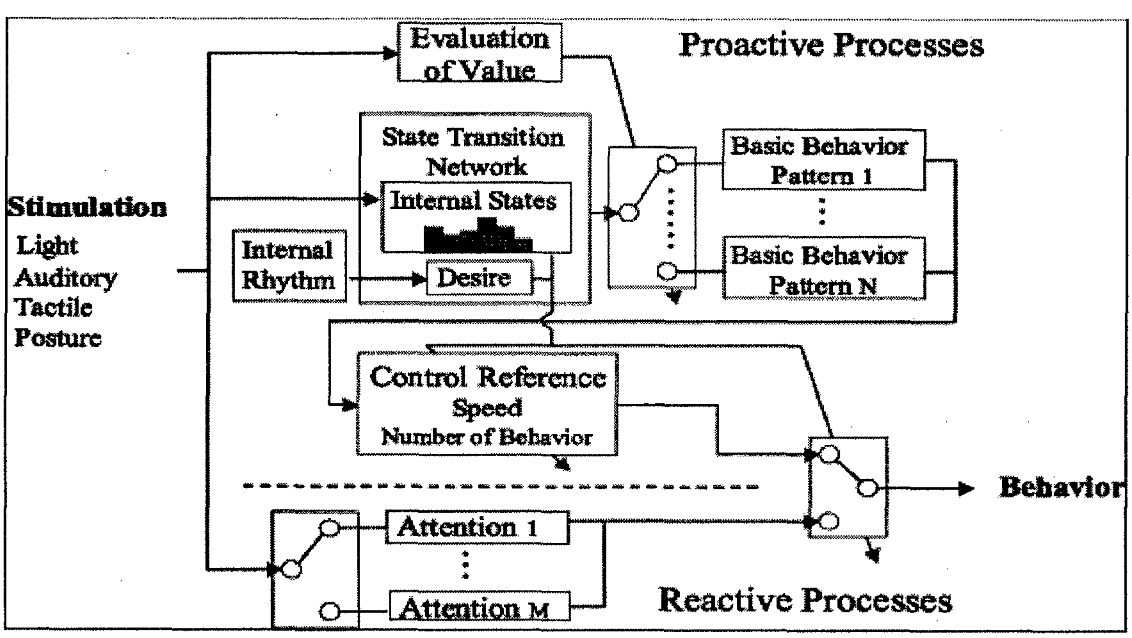


Figure 9: Behavior generation system of Paro

Considering internal states, stimuli, desires, and a rhythm, Paro generates proactive behaviors.

(a) Behavior-planning layer: This has a state transition network based on internal states of Paro and Paro's desire produced by its internal rhythm. Paro has internal states that can be named with words of emotions. Each state has a numerical level and is changed by stimulation. The state decays with time. Interaction changes its internal states and creates Paro's character. The behavior-planning layer sends basic behavioral patterns to behavior-generation layer. The basic behavioral patterns include some poses and some motions. Here, although "proactive" is referred, proactive behaviors are very primitive compared with those of human beings. We implemented behaviors similar to that of a real seal into Paro.

(b) Behavior generation layer: This layer generates control references for each actuator to perform the determined behavior. The control reference depends on strength of internal states and their variation. For example, parameters change speed of movement, and the number of the same behavior. Therefore, although the number of basic patterns is countable, the number of emerging behaviors is uncountable because numeral parameters are various. This creates life-like behaviors. In addition, as for attention, the behavior-generation layer adjusts parameters of priority of reactive behaviors and proactive behaviors based on strength of internal states. This function contributes to Paro's situated behavior, and makes it difficult for a subject to predict Paro's actions.

(c) Long-term memory: Paro has a function of reinforcement learning. It puts a positive value on preferable stimulations such as strokes. It also puts negative values on undesirable stimulations such as when it is beaten. Paro puts values on relationships between stimulation and behaviors. Gradually, Paro can be shaped to preferable behaviors of its owner.

(2) Reactive behaviors: Paro reacts to sudden stimulation. For example, when it hears a sudden loud noise, Paro pays attention to it and looks in its direction. There are some patterns of combination of stimulation and reaction. These patterns are assumed as conditioned and unconscious behaviors.

(3) Physiological behaviors: Paro has the rhythm of a day. It has some spontaneous desires such as sleep based on the rhythm.

2.2. Specifications of Placebo Seal Robot

We often lose interest in toys when we find their mechanism. Therefore, we considered the following hypothesis:

The robots that execute only defined simple motions have their motions predicted by people, and they lose interest in the robots. Moreover, the robots also stop having effects on those people.

According to this hypothesis, we changed regular Paro's program, and made a placebo Paro as follows:

Proactive behaviors: repetition of following five kinds of actions.

(1) Blink
(2) Swing rear fins to right and left
(3) Swing both front fins to forward and backward
(4) Swing head to right and left
(5) Cry. Return to (1)

Reactive behaviors: following simple reactions against stimuli.

(1) Cry (sound is different from proactive motion's cry)
(2) Raise head

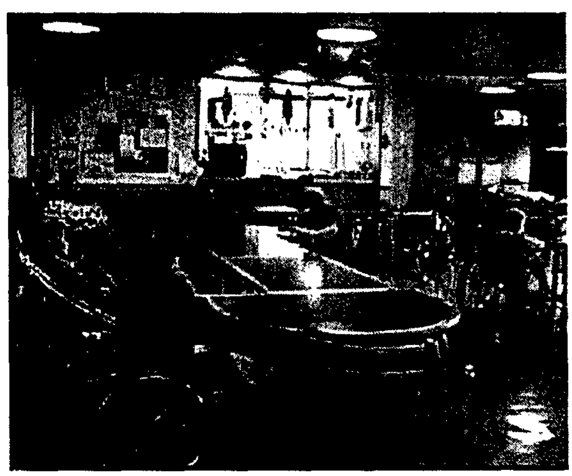


Figure 10: Scene of usual life of elderly people at a health service facility

3. ROBOT ASSISTED ACTIVITY FOR ELDERLY PEOPLE

We applied Paro to robot-assisted activity for elderly people at a health service facility for the aged in order to investigate its effects on elderly people. The health service facility for the aged is an institution that provides several services, such as long-term care at the institution, day care, and rehabilitation for elderly people. People who need nursing can stay there for a certain period. During their stay at the institution they are provided with daily care and trained to spend their daily life independently in order to rehabilitate them into society. When we began the study at the institution, about 100 elderly people were staying there. Moreover, about 30 of them had dementia. People who did not have dementia stayed in A and B building, while people who had dementia stayed in C building where they were isolated from other people.

Fig.10 shows a scene of usual life of elderly people who stayed at A and B building, which had a dark atmosphere.

The elderly did not communicate with each other much. The reason was a lack of common conversation topics. Moreover, the caregivers were too busy taking care of all the patients, and so they did not spent much time with each person.

Before starting the robot-assisted activity, we explained the purposes and procedures of the study to the elderly people who stayed in A and B building, and received their approval. As expected, the elderly people in A and B building were staying at the day center for a variety of reasons. Some people, however, were impossible to investigate. A nursing staff that was well versed in the usual states of the elderly people evaluated them, and decided who could be investigated. After the evaluation, there were 23 subjects. 12 subjects stayed in A building, and 11 subjects were in B building. Their basic attributes are shown in Table 1. (Note: AV means their average age. SD means their standard deviation.)

	A	B
Total number of people	12	11
Male	4	2
Female	8	9
Age(AV±SD)	84.6±7.0	85.5±5.4

Table 1: Basic attributes of 23 subjects

3.1. Ways of Activity

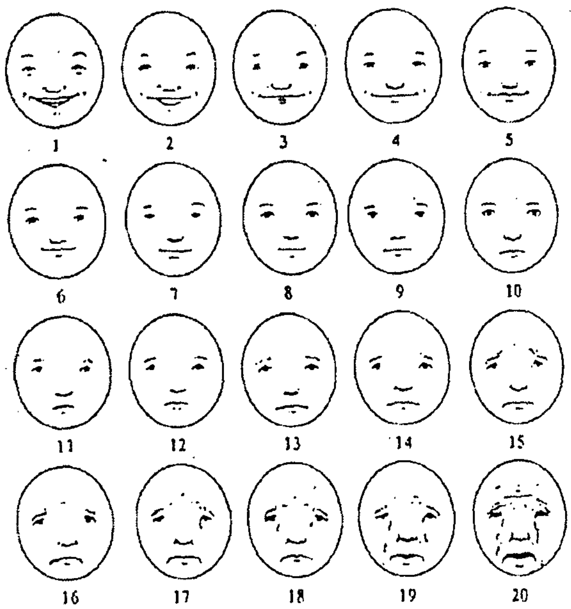
The regular Paro robot was provided to the subjects who stayed in B building, and the placebo was provided to the subjects who stayed in A building. In order to prevent the subjects of each group interacting with the other group's Paro, each group interacted with their Paro in a different place in the institution. Moreover, we kept the existence of two different kinds of Paro robots secret from the subjects. Each group interacted with their Paro for about one hour at a time, four days a week, for three weeks. We prepared a desk upon which to set Paro in the center of people, and the subjects were arranged up as shown Fig.11. However, not all the subjects could interact with Paro at the same time. Therefore, we moved Paro among subjects in turn, and we ensured that each subject's interaction time with Paro was the same.

Figure 11: Interaction between elderly people and Paro at a health service facility

3.2. Ways of Evaluation

In order to investigate elderly people's moods before and after the introduction of Paro to the institution, the following two kinds of data and information were collected:

(1) Face scale [21] (Fig.12)
(2) Profile of Mood States (POMS) [22]
(3) Comments of the nursing staff



INSTRUCTIONS: The faces above go from very happy at the top to very sad at the bottom. Check the face which best shows the way you have felt inside now

Figure 12: Face scale

The Face Scale contains 20 drawings of a single face, arranged in serial order by rows, with each face depicting a slightly different mood state. A graphic artist was consulted so that the faces would be portrayed as genderless and multiethnic. Subtle changes in the eyes, eyebrows, and mouth were used to represent slightly different levels of mood. They are arranged in decreasing order of mood and numbered from 1 to 20, with 1 representing the most positive mood and 20 representing the most negative mood. As the examiner pointed to the faces, the following instructions were given to each patient: "The faces below go from very happy at the top to very sad at the bottom. Check the face which best shows the way you have felt inside now."

The POMS is a well-respected questionnaire which measures a person's moods [22]. The POMS is used in a variety of research fields such as medical therapy and psychotherapy. It can measure six mood states at the same time: Tension-Anxiety, Depression-Defection, Anger-Hostility, Vigor, Fatigue, and Confusion. It has 65 items concerning moods. Each item was evaluated by five stages of 0-4: 0 = not at all, 1 = a little, 2 = moderately, 3 = quite a bit and 4 = extremely. 58 of 65 items are classified into the six mood states, and we calculate total scores of each mood states. (Note: 7 items are dummy items) Then, we translated the total scores into standard scores by using a special table.

4. RESULTS OF ROBOT ASSISTED ACTIVITY

The face scale and the POMS were applied to the subjects a week before the introduction of Paro, and the second and third week after Paro's introduction.

As for the face scale, we obtained data from 7 people in the regular Paro group, and from 11

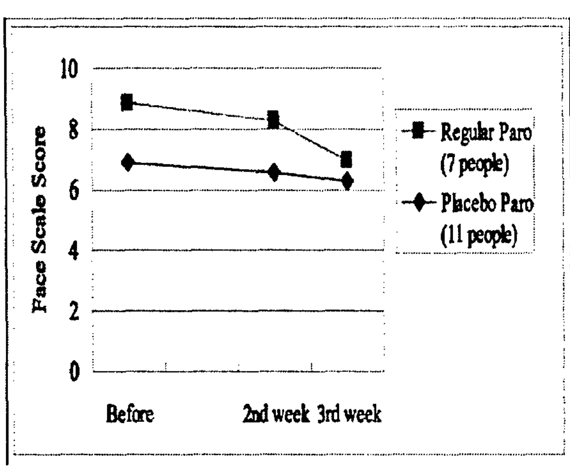


Figure 13: Average face scale scores of elderly people for 4 weeks

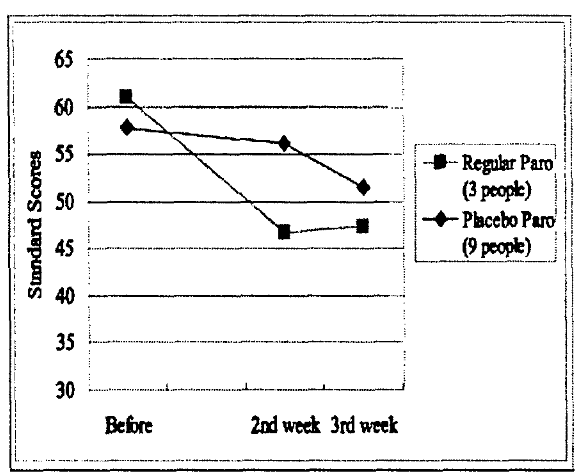


Figure 14: Average standard scores of "Depression-Dejection" of POMS of elderly people for 4 weeks

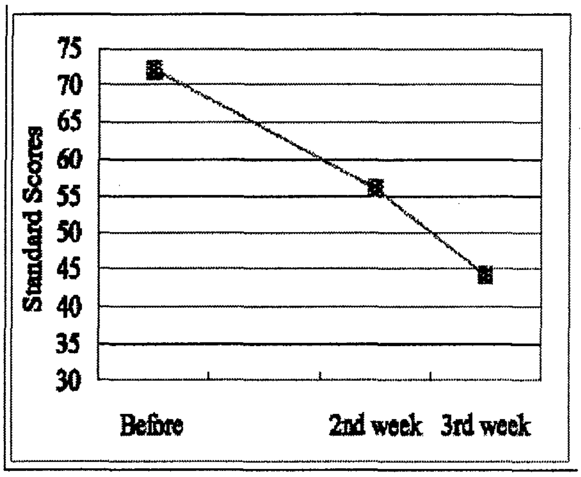


Figure 15: Standard scores of "Depression-Dejection" of POMS of an elderly person for 4 weeks

people in the placebo Paro group. Fig.13 shows average face value. Average scores of the regular Paro group decreased from about 9.0 (before introduction) to 7.0 (third week). Moreover, the average score of the placebo Paro group also decreased from about 7.0 (before introduction) to 6.3 (third week). Therefore, interaction with both regular and placebo Paro improved the mood of the subjects.

As for the POMS, we obtained data from three people in the regular Paro group, and from nine people in the placebo Paro group. Fig.14 shows average standard scores of Depression-Dejection. Here, 50 standard points means average score of Depression-Dejection of Japanese people over 60 years of age. Average standard scores of the regular Paro group decreased from about 61 (before introduction) to 47 (third week). Moreover, the average standard score for the placebo Paro group also decreased from about 58 (before introduction) to 51 (third week). Therefore, interaction with both the regular and placebo Paro decreased the levels of depression and dejection of the subjects.

Figure 16: Old man who was singing songs to Paro

In one striking instance, Fig.15 shows the result of a male subject aged 96 years old. He was usually not sociable, and caregivers could hardly communicate to him. Before the introduction of Paro, his standard score of "Depression-Dejection" as measured by the POMS was very high. However, after the introduction of Paro, he came to like Paro very much. He often laughed and sung songs to Paro when he was interacting with the robot (Fig.16). He also made the surrounding people laugh. Caregivers were surprised by his change. Moreover, his standard score dramatically decreased to 44 in the third week after Paro's introduction.

Figure 17: Elderly people who tried to feed snacks to Paro

Average standard scores of other factors such as "Tension-Anxiety," "Anger-Hostility," "Fatigue," and "Confusion" also decreased. However, these scores didn't change as much as "Depression-Dejection." Scores also decreased for "Vigor." We think this shows that people relaxed and calmed down by interacting with Paro. The nursing staff observed that both

groups of subjects were waiting for Paro and participated with Paro willingly. Paro increased their laughing, and encouraged the subjects to communicate with each other and the nursing staff. Moreover, some elderly people tried to feed snacks to Paro (Fig.17). In an interesting instance, an elderly woman who liked Paro very much made a song about the baby seal and sang it to the robot. She looked very happy after she did this.

5. DISCUSSIONS

We investigated the effects of Paro on elderly people who were staying in a health service facility for the elderly. Then, we compared the effects of the regular Paro against those of the placebo Paro. Contrary to our expectations, face scale scores of both the regular and placebo Paro groups improved, and their standard scores of Depression-Dejection of POMS decreased after introduction of Paro. This shows that both regular and placebo Paro improved elderly people's moods. Paro was especially effective at alleviating their depression.

Before the study, we expected that people would lose interest in the placebo Paro because its reaction was very simple. We were, however, mistaken. Subjects of the placebo Paro group kept interacting with their Paro and didn't notice that the placebo Paro's reaction was simple. Why didn't subjects lose interest in placebo Paro?

We consider the following two reasons:

(1) It was difficult for subjects to notice that placebo Paro's reaction was one pattern. Subjects interacted with Paro in groups of two or more people at a time. Therefore, each subject's interaction time with Paro was not as long for them to notice that its reaction was one pattern.

(2) They were not interested in the mechanism of Paro.

In general, elderly people's curiosity is lower than that of young people. Therefore, they didn't try to investigate mechanisms that made Paro work, and didn't notice that placebo Paro's reaction was simple.

In this research, we used the POMS questionnaire because it can measure six mood states accurately. However, it had many items, and some subjects refused to answer them with the passage of time. We will make more simple questionnaires to measure the moods of elderly people in future research.

6. CONCLUSIONS

We applied seal-type mental commit robots called Paro in robot-assisted activity for elderly people at a health service facility for the aged. The study was carried out for a total of 4 weeks. Then, we compared the effects of the regular Paro against those of a placebo Paro. The results show that interaction with both the regular and placebo Paro had positive psychological and social effects on elderly people.

Physiologically, we used urinary tests to objectively find that robot-assisted activity decreased stress reaction in the elderly clients. The details are described in Saito et al [23]. Now we are conducting a study that investigates the long-term effects of interacting with Paro on the elderly people at the same facility. The elderly people have been interacting with Paro for over 5 months. Interaction with Paro has improved their moods and encouraged them to communicate with each other. Moreover, they have maintained an interest in Paro, and they look forward to seeing Paro every time. Full details of this study will be presented in a later paper.
We plan to have further studies and to research different conditions and situations. Moreover, we will investigate the relationship between functions of a mental commit robot and its effects on elderly people in robot-assisted activity.

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Real Time Implementation of an On-Road Video Driver Drowsiness Detector: Two-Camera Profile Inputs for Improved Accuracy

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Abstract: *Drowsiness in drivers and pilots is a major cause of injuries and accidents. A real-time on-road alertness monitor is described whose output is derived from two laterally mounted video cameras outside the driver's field-of-view. Output from the system is a 12-channel scalar set that measures the frequency and duration characteristics of the driver's head position in relation to a standard driving position correlated behaviorally with alertness. The two-camera enhancement results in greater accuracy and stability allowing for validation studies with other parameters of alertness that are useful (such as electroencephalography) but not readily adaptable to the on-road environment. The processing methods described can be implemented in an embedded-processor configuration suitable for in-vehicle deployment.*

INTRODUCTION

Driver and pilot fatigue, as well as pilot impairment resulting from drowsiness or environmental factors of incapacitation, are major sources of accidents and injuries. An approach to continuous, practical, noninvasive, real-time, on-board video behavioral monitoring has been described by Steffin and Wahl.[1] That method provides the mechanism for extracting behavioral corollaries of drowsiness from salient changes in feature complexes involving stable facial regions (fiducials) including eyebrow-palpebral fissure complex (EPFC), the mouth region, and the facial boundaries. As a result of the video-to-scalar operation of that approach, 12 scalar data channels are generated for each of the video analysis subregions (SRs) in each of three major regions of interest (ROIs), head, EPFC, and mouth. The method previously described was limited by processing video data from a single centrally mounted windshield camera. A shape detection algorithm that filtered video data according to shape expectations of the respective SRs resulted in 12 scalar channels whose values were representative of the precision of alignment of the subject facial features to the standard facial position correlated with alertness.

However, this configuration partially impaired the driver's view, and was less than optimally sensitive and specific. Improvements in the technique include simultaneous input from two laterally mounted cameras that capture profile facial views rather than a frontal view. The result is increased resolution of facial features that are relevant to drowsiness.

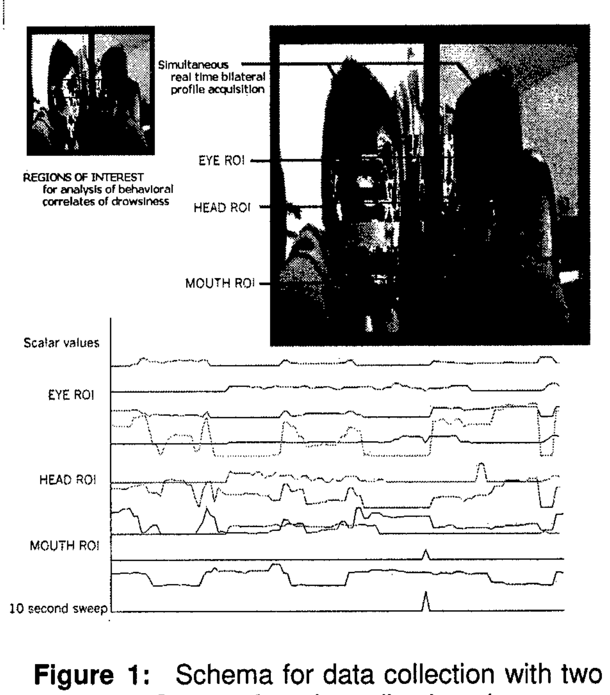

Figure 1: Schema for data collection with two cameras. Outputs from laterally placed cameras are transferred to a frame buffer for video-to-scalar image processing. Levels of processing include intensity discrimination of facial fiducials (left panel) and shape discrimination (right panel). See text.

Figure 1 shows the schema of this approach. Real time video from the two cameras is transferred to a frame buffer for analysis. Two levels of processing, intensity discrimination (upper left panel) and shape discrimination (center panel), allow derivation of 12 channels of data corresponding to the alignment of the facial fiducials (eye, head, and mouth) with the standard, straight-ahead position. Further, the profile schema generates comparison of the fiducial shapes in real time against shape references derived from the actual face in standard position, which may be grabbed as the driver first approaches cruising speed. This procedure enhances accuracy, as compared to the somewhat arbitrary shape discrimination functions employed in the previous method, and will simplify calibration of the system to the individual driver.

RESULTS

Figure 2 demonstrates the increased resolution of facial fiducials resulting from the improvements in facial video acquisition described. For clarity, identical video input is fed to both channels, and analysis is performed on the left channel. The active scalar outputs shown represent the mouth and chin regions for the left channels. In A, there is a clear downward deflection, with good signal-to-noise level in both active channels representing changes in configuration of the labial region (upper trace) and mental region (lower trace) at the time of mouth opening. The movements were on command, rather than as a result of a natural yawn, so the deflections are abrupt and stable, and give a good estimate of the frequency response and noise characteristics of the system. Similar deflections resulting from mouth closure, also on command, are shown in B. In C, a series of openings and closings are shown over a 10-second sweep.

Figure 3 shows a similar level of resolution and favorable signal-to-noise characteristics for eye blinks, also, in this instance, on command. The upper channel records eyebrow movement and the lower channel records the time characteristics of the palpebral fissure. In A, eye opening is followed by eye closure, while in B eye opening is the final state, as indicated in both the video and the scalar data. A series of eye blinks (on command) is indicated in C.

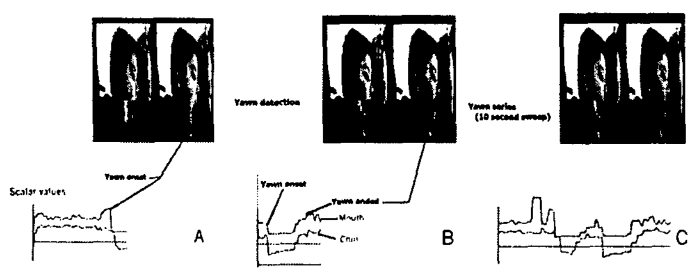

Figure 2: Yawn detection as implemented with the data collection method of Figure 1. A. Detection of mouth opening on command, as shown in video. Upper active trace: scalar for labial region; lower active trace: scalar for chin movement. B. Detection of mouth closing as in A. C. Series of openings and closings, 10-second sweep. See text.

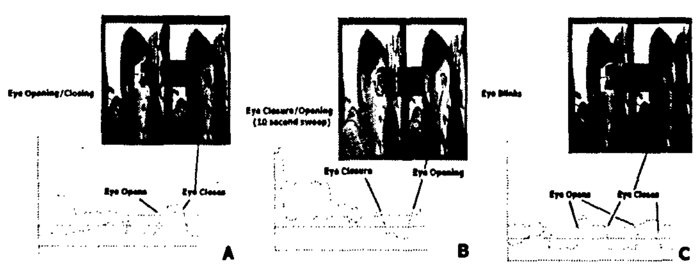

Figure 3: Detection of eye opening and closing on command, with same schema as Figure 2. A. Initial eye opening, then closing, as shown in final video. B. Eye closing followed by opening, as shown in video. C. Series of eye blinks on command, 10 second sweep.

DISCUSSION

The approach previously described (Steffin and Wahl[1]) represents methodology for extracting behavioral correlates of drowsiness from facial features with practicable hardware that can be reduced to a self-contained embedded-processor system. However, ergonomic factors of frontal camera placement cause driver inconvenience and tend to reduce the accuracy of the technique. The reliability of the measurements with this new configuration have increased, and the intrusion into the driver's field-of-view has been reduced by the dual camera monitoring techniques in the described implementation. As a result, the reliability of the technique appears to be significantly increased.

Future directions include enhanced compensation for ambient light variation. Initial considerations indicate that near infrared monitoring, as opposed to visible light, will provide further improvements in the stability of the system in daylight and will be required for this measurement system at night. Research is in progress regarding the data collection with limited infrared.

It is anticipated that the same attributes of efficiency in processing and coupling of system output to relevant driver behavior will be realized in the described configuration, so that a reliable system of drowsiness detection independent of ambient visible light will be achievable. Behavioral studies are underway to determine correlation of the scalars with more generalized measures of performance (such as reaction time and accuracy of obstacle avoidance) and with electroencephalographic monitoring of alertness as a prelude to on-road testing.

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Traffic safety investigations by means of an Augmented Reality Driving Simulation: Neurophysiological measurements in sleep deprived subjects

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Abstract: *The fact that driving performance gradually declines when individuals are driving a monotonous route for a longer period of time is well known. This effect of decreased driving performance is dramatically amplified when subjects have experienced sleep deprivation prior to the actual driving. The overall consequences of these performance decrements have been a major concern in society. It is widely accepted that fatigue and drowsy driving account for a large and most probably underestimated number of hazardous accidents. For methodological reasons the estimate of the prevalence stays difficult but the use of a virtual driving situation allows a promising method of approach to underlying psychophysiological mechanisms.*

In the present study a real-car based static augmented reality driving simulator was used in 41 subjects to investigate the performance and the vigilance state of professional and "normal" drivers after sleep deprivation. To monitor vigilance electroencephalography (EEG) was employed.

INTRODUCTION

Drivers who are impaired due to fatigue, illness or use of medication are thought to have an increased accident risk. However, there is no consensus in the literature on the relation between different impairments and traffic accidents. One estimates that around 30 % of all accidents have driver impairment such as drowsiness, alcohol/drug consumption or illness as a primary or secondary cause. This problem is common throughout Europe and accounts for 15,000 fatalities annually and 450,000 injuries in Europe alone. Whether a restrictive policy prevents accidents remains controversial especially when conclusive evidence is lacking (e.g. in some countries there is a complete prohibition of insulin-using drivers operating certain categories of vehicles). It is generally accepted that the ability of disabled people to drive a vehicle considerably enhances their work rehabilitation chances. Facing these issues, there is a demand to employ more accurate and reliable assessment methodologies to evaluate driving performance. It is especially important to investigate driving behavior of impaired drivers and to characterize typical patterns that could indicate increased risk of an accident. In the present study the intervention of a driver warning system (DWS) during driving performance was used to analyse the vigilance state in sleep deprived subjects. Therefore EEG was conducted as widely accepted Gold-standard to monitor vigilance[1]. The use of a real-car based static augmented reality driving simulator allowed neurophysiological access under laboratory conditions. The goal was to define a typical EEG response pattern (spectral changes after intervention of the DWS) indicative for sleep deprived subjects.

MATERIAL AND METHODS

Participants

The participants were selected to cover various types of drivers (passenger cars) regarding driver profile, driving experience, and age. Before inclusion in the study, each subject performed a test drive in the presence of a physician in order to identify kinetosis sensitive subjects. Information about possible adverse effects in the driving simulator was given before the subjects gave

their informed consent. Furthermore, they were given instructions on how to prepare for the experiment: Partial sleep deprivation during the night before the experiment (get up at 2.00 a.m. when the experiment started at 8. a.m.), and avoidance of coffee, tea, or energy drinks.

Experimental setup

To create realistic traffic scenarios in a laboratory environment, a passenger car simulator (deforest company) was used. The simulator provided:

- Computerized vehicle emulating the complete functionality of a modern city car
- PC-based visual system providing complex road and traffic scenarios
- PC-based audio and infra-sound system

Neurophysiological measures

Electroencephalographic activity was continuously recorded (bandpass 0.3 – 70 Hz) from 17 Ag/AgCl electrodes using a 32 channel cap (Easycap) based on the 10/ 20 system (F3, F4, C3, C4, T3, T4, T5, T6, P3, P4, Fz, CPz, Pz, A1, A2, O1, O2). Data were sampled at 250 Hz using BrainVision recorder software and a Brainamp amplifier (Brain products). All electrodes were referenced to Cz; for data analysis they were re-referenced to the linked earlobes (A1, A2). Horizontal eye movements were monitored from electrodes placed lateral to the right and left eye. Electrodes for the vertical axis were placed above and below the left eye. The DWS actions "drowsiness warning" and "fatigue countermeasures" were recorded along with the on-going EEG. The acoustic signal of the "fatigue countermeasures" and the confirmation reaction (button-press) were stored for further analysis.

A computer algorithm was used to attenuate eye artifacts contaminating the EEG signals[2]. The algorithm was applied to all EEG traces. Additionally 30 sec. EEG-time epochs were analysed and controlled for other artifacts (e.g. muscular origin). The EEG signals were quantified by use of fast Fourier transformation. FFT was calculated on the base of 2 sec. segments resulting in power values (μV^2) averaged for each defined frequency band: theta: (4 - 7.5 Hz); alpha: (8 – 12 Hz); beta 1: (12 – 18 Hz); beta 2: (18 – 30 Hz). The obtained absolute power values were transformed in relative power values based on the frequency range between 4.0 and 32 Hz. Further evaluation of spectral data followed two approaches: The numerical quantification of the "drowsiness warning" intervention focused on the pre/post-comparison of the 15 sec. segment before the drowsiness warning with segments (15, 30, 60, and 120 sec. duration) after the warning. These segments were also obtained by averaging artifact free 2 sec. segments for each frequency band and segment. Relative power was chosen to minimize individual differences across subjects in absolute power magnitude.

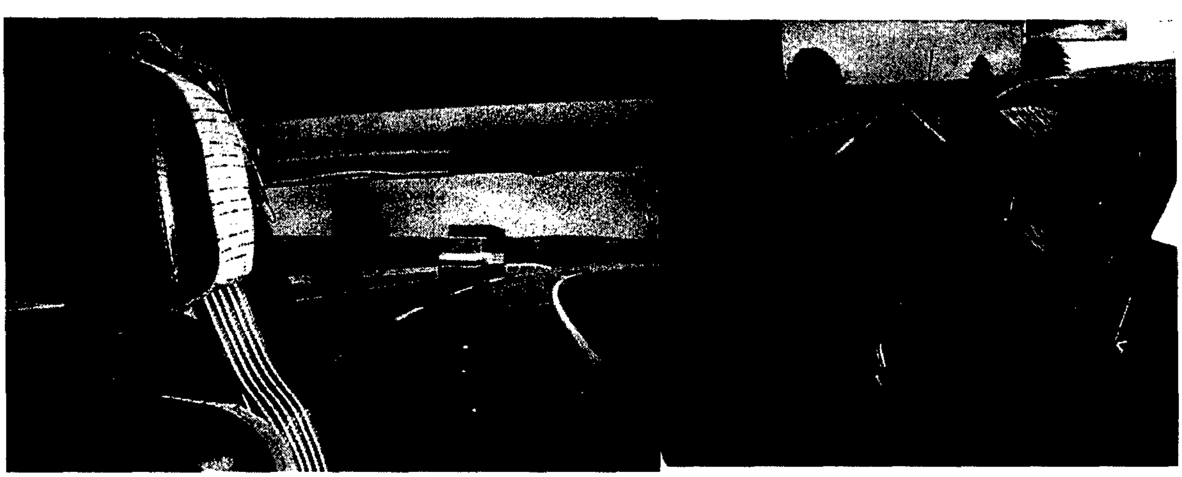

Figure 1: COAT driving simulator

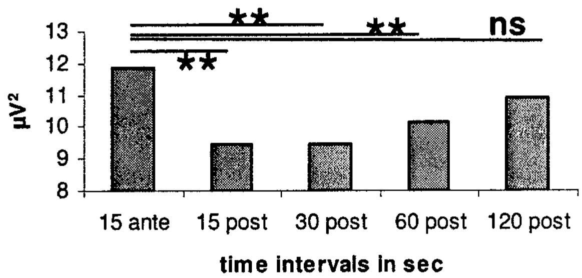

Figure 2: Plot of alpha power values at O1 pre- and post- DWS intervention (n=41; ** p < 0.01).

Statistics

Data was analyzed using descriptive statistical methods. Two-tailed one-way between subjects ANOVAs were used to carry out significant differences between the two age groups or between task conditions at every time point of measurement. An increase or decrease of physiological values relating to baseline was analyzed using paired *t*-tests.

RESULTS

Averaged relative power spectra in predefined frequency bands were analyzed pre- and post-intervention by the DWS. This approach was chosen to evaluate whether and how long the DWS under study was able to improve vigilance using EEG criteria. Even if the inter-individual differences in EEG morphology are remarkable, the goal of the approach was to look for more general responses that exhibit significance for the whole group.

<u>Alpha band:</u>

Fig. 2 gives the development of the alpha power for various intervals after DWS-intervention (n=41). The example refers to electrode O1 but the illustrated effect is also true for nearly all temporal, parietal, and occipital leads. Frontal electrodes did not indicate an effect on alpha activity for the whole group, but subgroup analysis could show a relevant change here. The time course of the alpha changes over time is illustrated in Fig. 3 for the whole group. It indicates that the 120 sec. segment post warning the effect is already diluted, and the pre-post comparison does not reveal a significant change any longer.

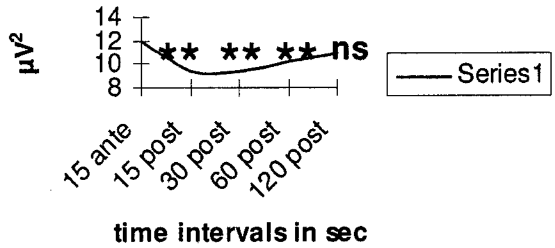

Figure 3: Fitted curve of pre-post alpha power (8-12 Hz) changes over time after DWS intervention at O1. Note the wash out of the induced effect (n=41;** p < 0.01).

<u>Beta band:</u>

Interestingly the beta 2 frequency band (power values between 18 and 30 Hz) was also a very consistent parameter, changing in response to the DWS-intervention. As shown in Fig. 4 the washout of the beta 2 changes took slightly more time compared to the changes of the alpha frequency band. The effect was observed at all temporal and occipital leads. Other frontal leads were excluded since an overlay by artifacts induced by muscle activity could not be sufficiently excluded. The quantitative beta 2 data correspond very well with the visual observations as shown in Fig. 1 & 2. The partially high amplitude theta or alpha activity is exchanged by a further desynchronized faster low amplitude beta activity. The analysis of the beta 1 frequency band (12-18 Hz) does not reveal

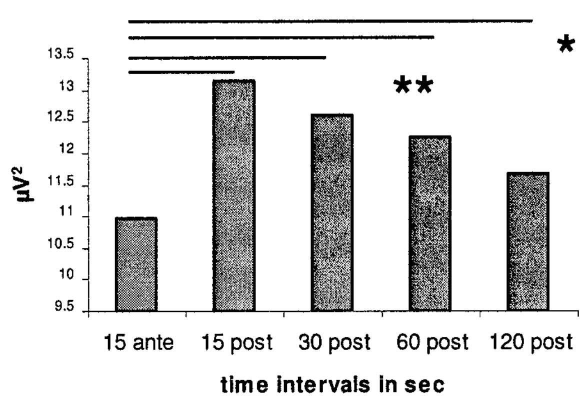

Figure 4: Development of beta 2 power (18-30 Hz) values after DWS-intervention at O1. Note that there is still a significant effect in the 120 sec post- segment (n=41;** p < 0.01; * p

significant group effects (n=36). One reason for this might be the inclusion of the 12-14 Hz range that individually decreases after DWS intervention and might compensate the effect.

Theta band:
Finally, the evaluation of the theta frequency band was performed. Several subjects showed a marked decrease of theta activity after DWS-intervention. But the theta effect in the whole group revealed contrasting data (Fig. 5). There was an increase of theta power reaching a maximum in the 30 sec post-DWS epoch; afterward a washout took place. Since significance was only reached over central leads we think that the effect is probably not mediated by increasing artifacts (no significant effects at fronto-temporal leads). In contrast, we suggest a theta generation that reflects the mental effort to deal with the situation and react correctly.

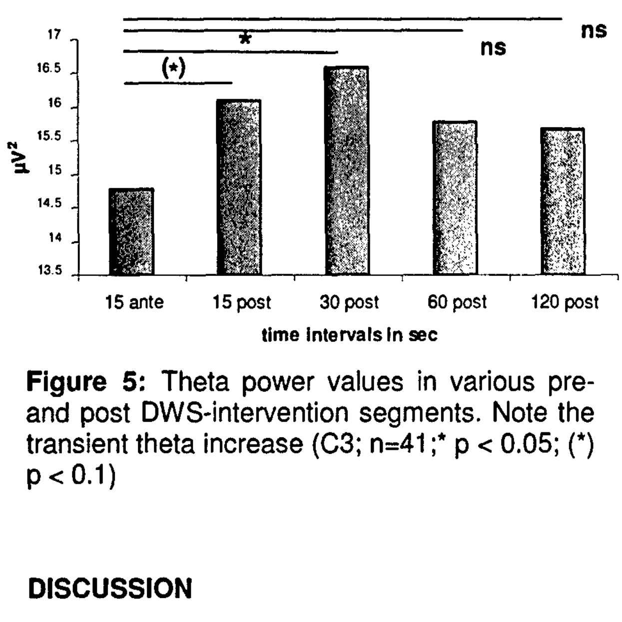

Figure 5: Theta power values in various pre- and post DWS-intervention segments. Note the transient theta increase (C3; n=41;* $p < 0.05$; (*) $p < 0.1$)

DISCUSSION

In the present study electroencephalographic activity was investigated in sleep deprived subjects during performance in a driving simulator. The use of EEG parameters is well documented to estimate vigilance and awareness during monotonous performance[3-5]. For analysis two different approaches were chosen. First, the development of absolute and relative power spectra was calculated over time using 30 sec. segments covering the complete test session, including baseline. Second, spectral power values were calculated in respect to the interventions by the drowsiness warning. Within the latter approach power spectra for various time intervals between 15 sec. and 120 sec. pre- and post-drowsiness warnings were calculated and compared. Despite the marked inter-individual differences in EEG morphology, statistical evaluation of the pre-post comparison revealed robust spectral EEG changes induced by the driver warning system (DWS):

Prior to the DWS intervention most of the subjects showed a widespread alpha baseline activity (8-12 Hz), which indicated drowsiness since eyes were opened during the driving performance. Some of the subjects even revealed a high amplitude anterior accentuation of alpha activity reflecting a further decrease of vigilance. Another subgroup showed a dominating theta activity with fluctuating alpha activity corresponding to sleep stage I. All these groups consistently decreased in alpha power in response to the drowsiness warning. There was a remarkable washout of this effect within a few minutes. Since the anterior distribution of alpha activity varied inter-individually the most robust electrodes for the described observation were located at temporal, central, and occipital positions.

After baseline measurement beta activity decreased over the course of the driving performance (as illustrated by continuous spectra) reaching a low level prior to the DWS intervention. Thus the pre-post comparison revealed a marked beta increase, most consistently observed in the beta 2 frequency band (18-32 Hz). Corresponding to the changes in the alpha activity the beta effect dropped a few minutes after intervention. The described spectral changes were repeated individually several times when the drowsiness warning was successively engaged. This supports the estimation of a robust finding, even if some subjects did not show any change in the alpha range. Interestingly, the expected changes in the theta frequency band were not consistently observed. In a subgroup a marked decrease was observed but this effect did not outlast in the statistical analysis regarding the whole group. In contrast, there was even a significant increase of theta activity (grand average) in response to the drowsiness warning at frontal and central leads. This paradox effect might be partially due to the increase of artifacts since frequently subjects start to move; the number of eye movements/blinks are increased

and might contaminate spectra as well. Nevertheless it cannot be excluded that theta generation is also part of an arousal reaction.

In summary the study gives evidence that the use of a real-car based static augmented reality driving simulator is a valuable approach to develop psychophysiological probes indicative for drowsiness during driving. In the present report the introduced electrophysiological probe specifies the extent and the duration of a DWS mediated effect on vigilance.

Acknowledgement:

EU – funded project AWAKE, Contract Number: IST-2000-28062
Grant Number: 01.0008 , Swiss Ministry of Education and Science (BBW)

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Virtual Driving in Individuals with Schizophrenia

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ABSTRACT: *Driving is an everyday, complex behavior that requires multiple cognitive processes including visual perception, divided attention, and working memory. Schizophrenia is a psychiatric disorder that often affects these cognitive processes critical to driving. We constructed a desktop driving simulator to test how well individuals with schizophrenia would respond to a variety of everyday driving situations relative to healthy participants.*

Patients and age-matched controls were confronted with a simulated 2-lane road with traffic and were instructed to obey all traffic laws, including the speed limit. After two rehearsal driving periods of 5 minutes, participants drove a 5-minute experimental route. At the end of the experimental drive, as the subject approached an intersection, a car stopped at a STOP sign illegally entered the intersection, stopped, and blocked the driver's path. The driver attempted to avoid a collision.

Overall behavioral measures included driving speed, stopping distance, weaving, and near-misses. The results indicate that individuals with schizophrenia made significantly more white line errors, and had a trend toward more yellow line errors and collisions. Additionally, patients drove significantly slower than control participants. This slow driving speed by the patients could be a byproduct of the negative symptoms or cognitive problems associated with the disease, or may result from medications. Alternative explanations for this performance difference, such as compensating for slow cognitive processing or recruitment from other brain areas, are also discussed.

INTRODUCTION

Driving is a day-to-day behavior requiring multiple cognitive processes. When driving, one must be able to perceive the environment accurately in order to drive safely. Also, a driver must be able to attend to multiple stimuli. For example, it may be necessary to pay attention to the brake lights of cars in front of the driver, as well as signs and other cars on the road. Additionally, working memory is often crucial for driving because the driver must remember street names and goal locations.

A problem in psychiatric illnesses is that impaired functioning and driving skills are often not apparent to physicians, family members, or the patients themselves until they are involved in traffic accidents[2, 5]. Schizophrenia is a psychiatric disorder that often affects cognitive processes essential for driving. Schizophrenia typically disrupts the ability to identify reality, recall situations, concentrate, make judgments, interact with others, and think clearly[16].

Many studies indicate that schizophrenia impairs many of the cognitive processes involved in driving[6, 8, 10]; however, it is still unclear which symptoms of the disease are the most debilitating for everyday functioning, and how this disease affects driving skills[8]. For example, it is well documented that patients with schizophrenia suffer from deficient working memory, divided attention[7, 8], and have longer reaction times than controls[14]. Clearly, a quicker reaction time affects driving, through such necessities as the ability to respond quickly if the situation demands it. Individuals with schizophrenia make more errors on complex operations such as distinguishing between figures and the ground[6]. Such skills also seem critical for perceiving driving cues such as distinguishing between a pedestrian in the road from a far-off crowd.

Because people with schizophrenia might be predisposed towards less safe driving behavior, the link between mental illness and driving poses an important research question, as the majority of people with schizophrenia live and may drive in the community at large[2]. Prior research suggests that people with schizophrenia have impairments in driving. For example, patients with schizophrenia have a significantly higher risk of having an accident per mile[5] (two times the number of accidents as controls, per mile driven[16]). However, in a separate study using a sample of mixed psychiatric patients, researchers found no difference from age-matched controls in number of single accidents, speeding, or unsafe yielding[4].

In the current study, we constructed a desktop driving simulator to test driving skills and see how an individual would respond to everyday driving hazards (e.g. children running in front of the car, cars running red lights, a car running a stop sign, etc.). We hypothesized that people diagnosed with schizophrenia would, as a group, display driving impairments.

METHOD

Participants

11 individuals (10 males, 34.9 $\pm$ 11.2 yrs. avg. age) with schizophrenia or schizo-affective disorder and 15 controls (8 males, 24.1 $\pm$ 5.4 yrs. avg. age) were tested. All participants had valid drivers' licenses and were asked specific questions about their driving behavior; for example, we collected information relating to driving frequency, whether the individual restricted themselves to only driving during the daytime, or only to familiar routes. All participants were paid $20 for their participation in the study.

Hardware

The simulator program was run on a PC desktop computer with a 19" LCD Flat Panel display. A Logitech Momo steering wheel with gas and brake pedals served as the input devices.

Software

The virtual environment was created and rendered with 3D Game Studio. All World Definition Language code and C-script code was written by the last author. Behavioral data of movement, trajectories, speeds, and events throughout the environment were analyzed using code written in C by Robert S. Astur. Throughout the simulation, the participant was situated in the driver's seat, and a speedometer and tachometer appeared on the virtual dashboard.

PROCEDURE

Participants were placed on a simulated 2-lane road with traffic and were instructed to obey all traffic laws, including the speed limit, which was 40 mph with a 20 mph minimum. Initially, the participant completed two 'warm-up' runs of 5 minutes each to acclimatize the driver to the software and hardware. For behavioral measures, white line errors were recorded when the participant crossed the white line on his/her right side of the road. White opposite line errors were recorded when the vehicle traveled over to the opposite lane and crossed its white line. Additionally, a participant made a yellow line error when his/her vehicle crossed the middle line. Collisions were also tallied.

In these rehearsal runs the number of white errors, white-opposite errors, and yellow line errors, as well as number of collisions, were displayed on the screen. Each time the vehicle crossed a line, a tone sounded to notify the participant that they had made an error. Each error had a tone set to a different frequency in order to help the driver determine which error they had made.

After the warm-up driving sessions, participants drove a 5-minute experimental route on a rural road with other cars. At the end of the experimental drive, the driver encountered a hazard. Specifically, the driver followed a lead car that passed through an intersection that had two cars stopped perpendicularly at stop signs. This lead car established that both the lead car and the driver had right-of-way through this intersection. After the lead car passed safely through the intersection and the driver approached the intersection, one of the stopped cars illegally entered the intersection, stopped, and blocked the driver's path. The driver was forced to avoid a collision. Immediately after passing through the intersection, a parked car appeared in the driver's lane, and it was again necessary to avoid a collision. Behavioral meas-

ures included driving speed, stopping distance, weaving behavior, near-misses, and collisions. Throughout all driving, car position and speed were recorded at 20Hz.

RESULTS

Results for driving errors in both patients and controls are depicted in Figure 2. In terms of driving errors, individuals with schizophrenia drove more erratically as indicated by line errors. Specifically, patients committed significantly more yellow line errors than controls, t (24) = -2.46, $p<.05$. Additionally, individuals with schizophrenia had significantly more white line errors than controls, t (24) = -1.992, $p<.05$, one-tailed. In terms of collisions, people with schizophrenia were approximately three times more likely to get into an accident (an average of 0.3 $\pm$ 0.8 for controls, vs. 0.9 $\pm$ 1.4 for patients), although this did not reach significance (p=.08, one-tailed).

In terms of driving speed, individuals with schizophrenia drove at a significantly slower median speed than controls, t (24) = 3.130, p=0.05), and at a significantly slower average speed compared to controls, t (24) = 2.523, p=0.02 (see Figure 3). It is of note that the average speed for 6 of the 11 patients (54.5%) was below the minimum posted speed of 20mph.

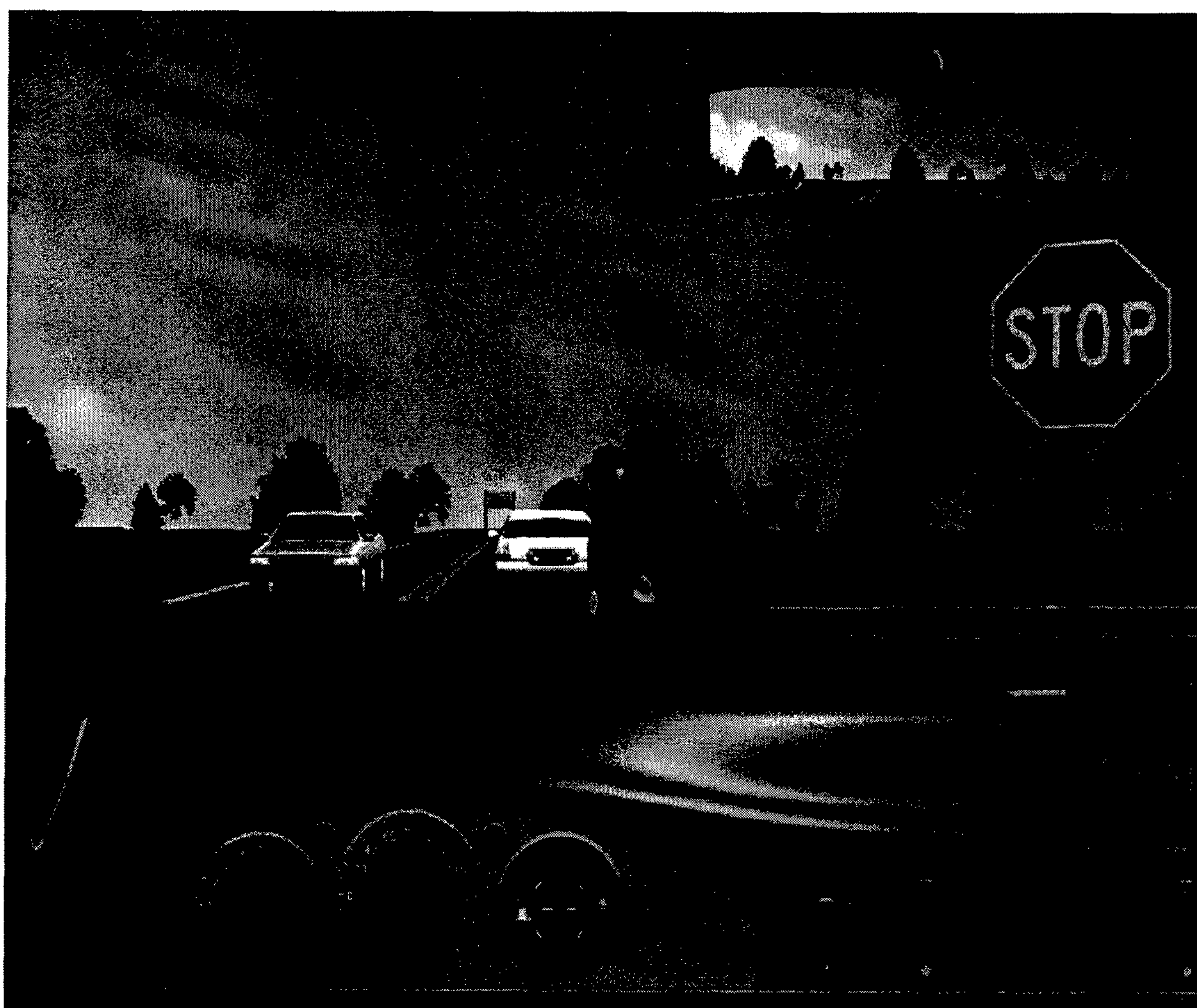

Figure 1: A screenshot of the virtual driving simulator.

DISCUSSION

In support of our hypothesis, we observed that people with schizophrenia displayed impairments on the driving simulator relative to control participants. Specifically, patients committed significantly more white and yellow line errors, and showed a trend toward more collisions. This increase in white line errors demonstrated that patients were weaving over on the side of the road adjacent to the curb. The fact that patients made more yellow line errors is potentially more disconcerting, as these are indicative of crossing over the center of the road, and such errors may result in swerving into oncoming traffic. In addition, patients were approximately three times more likely than controls to get into a collision.

The weaving errors are noteworthy because in addition to making more driving errors, patients also simultaneously drove significantly slower than the control participants. The speed limit was posted as 40mph, with a 20mph minimum. However, 55% of the people with schizophrenia drove at an average speed that was below the minimum, while 0% of controls drove below the minimum on average. In sum, patients were driving slower but still making more errors than control participants. People with schizophrenia clearly showed impaired driving behavior on our simulator, which suggests that patients' real-life driving may also be impaired.

It is not apparent why people with schizophrenia make more driving errors despite driving slower than normal participants. Schizophrenia is diagnosed through the presence of negative and positive symptoms, and historically research has focused more on the positive symptoms of the disease (false beliefs, hallucinations, bizarre behavior, and disjointed thoughts) [1]. Positive symptoms could have an impact on driving skills. For instance, someone who has more hallucinations may have difficulty perceiving the driving environment. However, it has been suggested that negative symptoms (flat affect, poverty of speech, loss of motivation, loss of pleasure in previously enjoyable activities, poverty of thought, and impairments in attention[1]) are actually more accurate predictors of everyday functioning[7, 8, 9]. Thus, negative symptoms may also be an indicator of a slower cognitive processing speed. It is of note that negative symptoms and cognitive impairment have substantial overlap but are not isomorphic and can be dissociated—one does not necessarily imply the other.

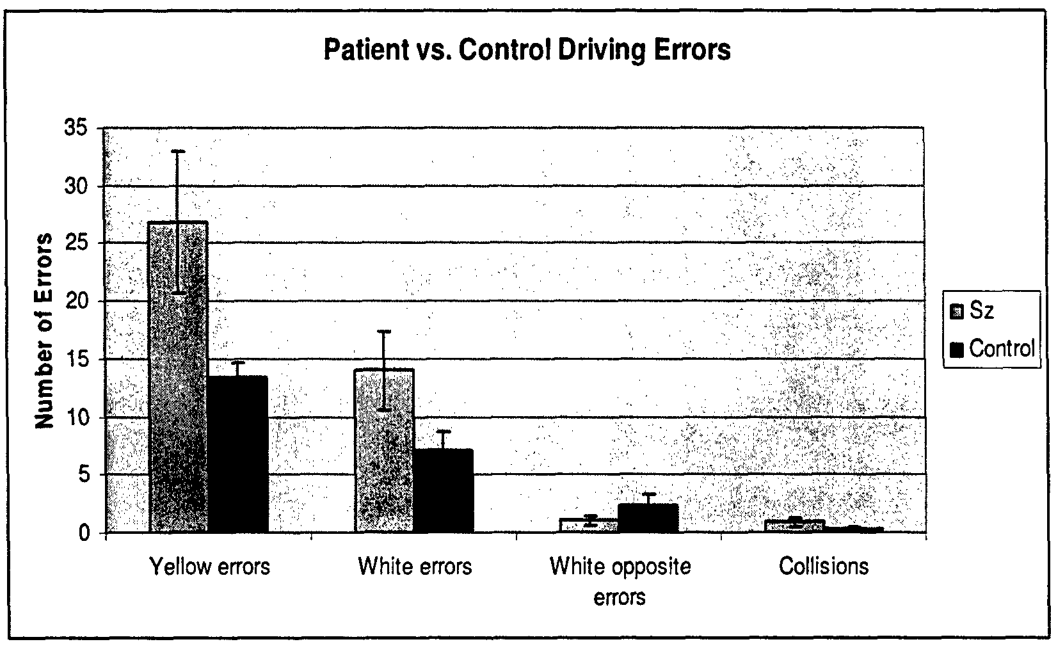

Figure 2: Driving errors for the two groups. Individuals with schizophrenia made significantly more white and yellow line errors and displayed a trend toward more collisions.

In terms of driving speed, it may be that the patients are driving slower to compensate for their slower cognitive processing. For example, they might be aware of their impairments, choose to slow down, and allow more time to respond to objects in the environment. Thus, slow driving speed may be a byproduct of the negative symptoms of the disease. Whereas it was beyond the scope of the current experiment to correlate this symptomology with driving behavior, we plan to make such correlations in future experiments.

In addition to exploring symptoms of schizophrenia, neuropsychological testing may provide insight as to why people with schizophrenia drive differently than control participants. Many neuropsychological tests assess cognitive skills essential for driving, and accordingly, may predict accident risk during driving. For instance, the Trail-Making Test [15] is a timed visual sequencing and speeded set alternation test, which has been shown to predict crashes in older people[10]. Additionally, the Useful Field of View test (UFOV) measures visual processing speed, selective attention, and divided attention[11]. The UFOV is particularly known to accurately and specifically identify drivers involved in vehicle crashes, and to predict car crashes in a 3-year follow-up[11, 12]. Additionally, visual perception tasks such as the Motor-Free Visual Perception Test- Revised (MVPT-R)[3], test visual memory, hidden figures, and partial representations have been reported to predict accident risk in elderly drivers[10]. Accordingly, since people with schizophrenia are often impaired in these skills, neuropsychological tests might provide additional or complementary information to that provided by the driving simulator.

Other issues to consider in future driving studies with this patient population are driving experience, computer experience, and patients' medication. For instance, two participants could both describe themselves as driving 'frequently', but one may drive for long periods, while another may drive a few minutes a day for only a few days. Likewise, some participants may have more experience with computer and video games, which might give them an advantage on the simulator. Additionally, it is not clear how the patients' medications affect their driving skills: These factors will be included in future projects. However, these factors notwithstanding, it is important to remember that independent of which specific factors contribute to these driving

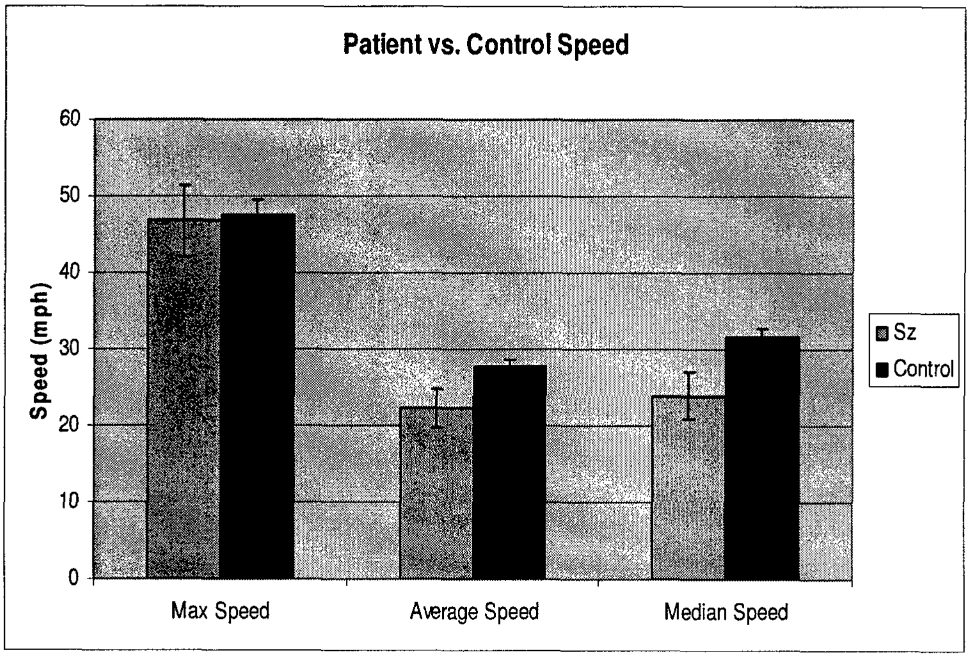

Figure 3: Driving speed for the two groups. Individuals with schizophrenia drove at a significantly slower speed than controls.

deficits, individuals with schizophrenia who drive show driving impairments in this simulator on a variety of dependent measures.

In this study, we have demonstrated a safe way to analyze driving skills. Using our simulator, we can program both routine and hazardous scenarios and analyze driving performance. The desktop simulator may potentially identify an impaired driver before that person becomes hazardous to himself and others on the road. Another important research advantage of this driving simulator is its compatibility with non-invasive brain imaging procedures such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG). fMRI enables researchers to infer brain activity during a task, while EEG allows clinicians to monitor the origin and degree of electrical activity in the brain. Both procedures provide valuable data as to which parts of the brain are being used during complex behaviors such as driving.

Some of our other current projects involve examining people with other neuropsychiatric disorders on the driving simulator. We are studying such disorders as strokes, epilepsy, Alzheimer's disease, mild cognitive impairment, and traumatic brain injury. We are also investigating the effects of abused substances (e.g. alcohol and marijuana) on driving behavior. Future planned studies will use this simulator for cognitive rehabilitation following traumatic brain injury or stroke. We have also begun to use the simulator in an fMRI paradigm where we can study the neural systems involved in driving.

In summary, we created and tested a viable desktop system to test driving skills. The simulator is potentially usable with all individuals – with or without a psychiatric illness. In our pilot project in individuals with schizophrenia, we found that patients displayed impaired driving skills relative to control participants. The patients' difficulties with line errors, collisions, and maintaining a minimum speed could indicate real-time driving impairments, which will be a focus of future research.

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A Clinical Protocol for the development of a Virtual Reality behavioral training in Disaster Exposure and Relief

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Abstract: *This paper deals with the development and evaluation of two different virtual reality cognitive-behavioral treatment settings and compares their effectiveness in disaster preparedness and acute stress response (ASR). Given the extent of the mental health problems following or anticipating large-scale natural or human made disasters, a brief, effective and cost-effective treatment intervention is urgently needed. A common and limiting characteristic of the above interventions is the fact that they are post-disaster interventions. That is to say, beliefs, attitudes, and behaviors of interest were assessed and treated after the occurrence of the various disasters. Consequently, conclusions concerning the impact of disasters on these types of variables and even predisposing factors have been largely based on post-hoc data. In the present study, we are investigating predisposing factors that relate to "seismophobia", using a virtual reality setting and biopsychobehavioral correlates. No experimental research has examined the hypothesized factors related to readiness and level of control of youth in real-time disaster exposure, in order to provide effective pre-disaster stress inoculation training. This study continued work done in correlational studies and uses two different virtual reality settings to examine the role that these settings play in helping increase normal youth and survivors' problem- and emotion-focused coping. Children (n=* 209) *were randomly assigned, based on a school classroom from three earthquake sites in Greece, to a condition. The "plain emergency condition" consisted of a realistic virtual earthquake scenario program, occurring inside a school classroom populated with behaviorally realistic, unfamiliar faces on digital avatars. The "familiar faces" condition consisted of the usual condition combined with avatars using familiar co-student faces. Factors assessed included both problem- and emotion-focused factors: knowledge of mitigation and emergency response activities, school and home hazard adjustments, hazard-related fears, emotion-focused coping ability, and perceptions of co-students' hazard-related fears. Overall, the results supported the role for pre-disaster virtual reality programs in increasing resilience in youth. In particular, large intervention-produced effect sizes were seen as both normal children and survivors reported hazard adjustments. Significant interactions provided additional support for the role of a familiar faces focus in the problem-focused areas of (1) both normal children hazard adjustments and (2) survivors increased preparedness self-efficacy and stress inoculation. These initial findings provide a continuing foundation for further research in this emerging area. Discussion considers the role for such programs in the future and the possible role of a treatment focusing on familiar faces in rapid recovery from traumatic stress.*

1. INTRODUCTION

Numerous studies of risk have attempted to isolate factors related to readiness for a future hazard. Perceived personal consequences are thought to relate to the level of control one has over available coping resources given the potential for a particular stressful event. In addition to risk perception[1], two other precursor variables are proposed. Critical Awareness (the extent to which people think and talk about a specific hazard) is an important precursor[2] and reflects the relative importance of natural hazards to a person. Only when they are perceived as salient or critical will such hazards motivate protective behavior. Given their destructive potential, earthquakes can represent a source of anxiety and reduce the likelihood that people will prepare[3,4]. This is illustrated in Figure 1. If risk perception, critical awareness of hazards, and hazard anxiety are present at appropriate levels, a person will progress to the next phase, forming intentions to adopt. Progression between motivation and intention formation is, however, influenced by another set of variables (Figure 1).

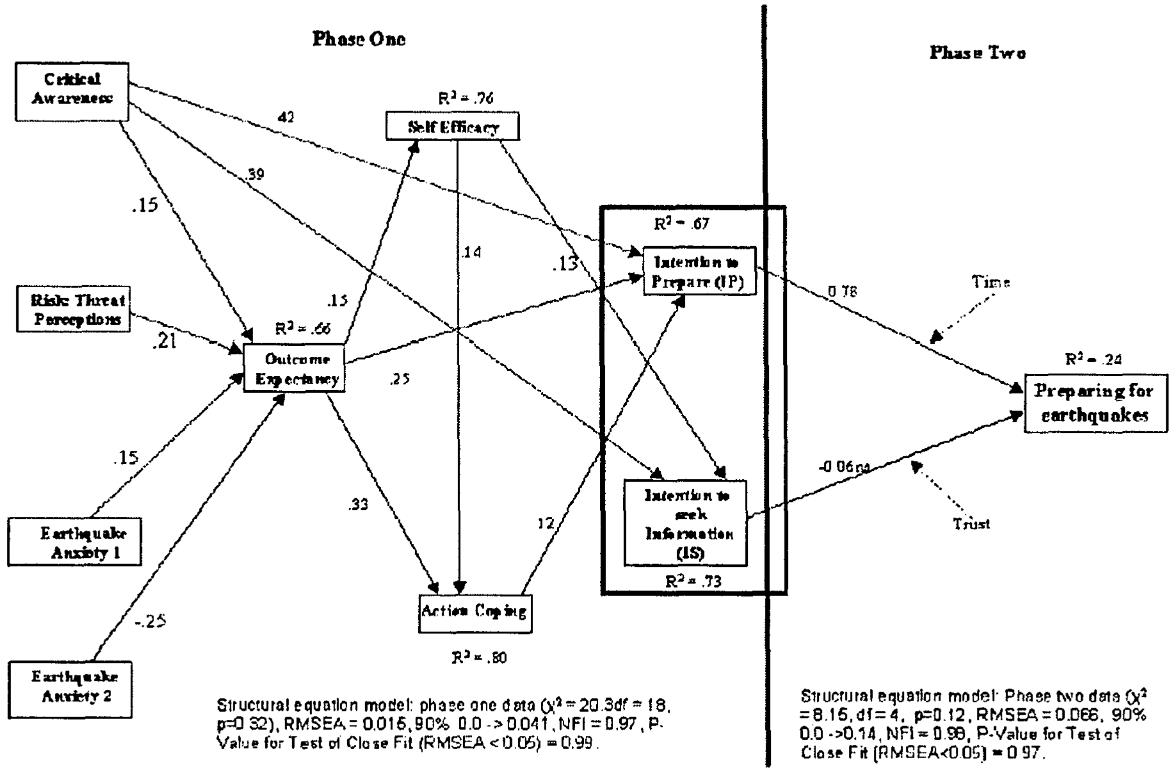

Figure 1: Combined Phase One and Phase Two Structural Models

Lazarus and Folkman described a model for coping with stress that delineates between problem- and emotion-focused coping resources. Problem-focused resources are aimed at "doing something to relieve the problem" and, in some ways, "are similar to strategies used for problem solving often directed at defining the problem, generating alternative solutions, weighting the alternatives, choosing among them, and acting"[5]. Of course, these strategies can be aimed both outwardly (i.e. the environment) as well as inwardly (i.e. the self)[6]. In terms of responding to risk information, problem-focused resources would include: factual knowledge related to readiness and response behaviors (i.e. knowing what to do in the event of a hazard) as well as more performance- or behaviorally-based forms of readiness. In the present context, this would include actually doing something, such as engaging in risk reduction activities. These activities, also referred to as hazard adjustments, include efforts aimed at both hazard mitigation (passive protection) and emergency preparedness (active response)[7].

Emotion-focused coping revolves around the idea of emotion regulation[5]. This form of coping can include emotional regulation directly as well as strategies aimed at increasing emotional regulation. In the former category, this would include reduced fear levels in relation to various stimuli (e.g. hazards)[6]. In the latter category, one way to increase the potential for emotional regulation is through adaptive cognitive appraisal. For example, in the current context, this would include one's appraisal of or confidence in the ability to cope emotionally with a current or future stressor, including a hazardous event[8]. An additional factor here that has been shown to be salient for children is the perception of parental levels of distress moderating their own fear levels[9].

As pointed out by Lazarus and Folkman, each form of coping is usually involved in a given situation, though it may not be able to be identified explicitly. However, the two forms of coping have been demonstrated to some extent in risk-related research with adult samples. For example, a lack of awareness and knowledge, combined with unrealistic risk perceptions, have been

shown to have a negative impact on preparedness and responses to warnings[10-12]. Recently, Sjoberg has pointed out that such factors (e.g. unrealistic risk perceptions) may be exacerbated by hazard-related fears[13].

In terms of child samples, previous research with 400 children and young adolescents in school settings found relationships between problem-focused and emotion-focused factors[8]. For example, this study found, like Sjoberg's, that children demonstrating unrealistic risk perceptions (i.e. those perceiving low-frequency events at a high rate) also had much greater frequencies of hazard-related fears (by a factor of more than 2), and lower levels of confidence in their ability to cope emotionally with a future hazard as compared to children with more realistic risk perceptions. In addition, the fearful group of youth also demonstrated consistently lower levels of knowledge about emergency response compared to less fearful children. These findings underscore the potential value of addressing both problem- and emotion-focused factors in research and applied settings.

Given such findings, it comes as no surprise that children who demonstrated more realistic risk perceptions/more knowledge/less fear had been exposed to hazards whereas their counterparts, who had decreased knowledge/unrealistic risk perceptions/increased fear had not been[14]. In addition, children involved in disasters reported increased perceptions of being hurt physically in the event of a range of hazards compared to children not involved. However, these same children, when compared with those children not involved in disasters, also reported a lower frequency of hazard-related fears (12% versus 28%, respectively, reported feeling often scared) as well as lower levels of perceived fears in their parents (9% versus 22%, respectively). Further, the more children were involved in disasters (i.e. two or more disasters), the more they derived benefits[15].

Critical awareness, risk perception and anxiety predict outcome expectancy. The role of anxiety was more complex than anticipated. Possibly the most interesting relation is the finding that 'intentions' comprise two variables: 'Intention to Prepare' and 'Intention to Seek Information'[16]. Critical awareness demonstrated direct and indirect relationships with both 'Intention to Prepare' and 'Intention to Seek Information', reiterating the relative importance of critical awareness as a motivating factor. The general findings are that children's reactions to hazards are based on a combination of factors that include (1) direct exposure to the hazard combined with the perception of increased physical risk, (2) pre-existing characteristics (e.g. demographic factors including medical factors, age, gender, ethnicity; pre-existing emotional problems), (3) availability of adaptive coping ability and resources, (4) access to social and family support, and (5) the occurrence of major life stressors (e.g. parental divorce, family death) following the hazard[7-9].

One stressor for children appears to be perceptions of co-students distress. That is, research following a hazard has found that those children perceiving greater levels of co-students distress were also seen to cope less effectively in the aftermath of a hazard[8]. The implication here is that the perception of decreased co-students upset in relation to hazards has benefits for youth. This study is attempting to model all of the above factors into a virtual reality scenario and propose a generic hazard preparedness and relief clinical protocol tailored to individual children profiles.

2. DESIGN

2.1. Overview of the Design

The current research was designed to provide information concerning various aspects of emotion- and problem-focused coping in a sample of Greek school children. The following areas were assessed: emotional factors (level of hazard-related upset in children and perceived emotional coping ability) as well as children's knowledge of hazard mitigation and emergency response behaviours. In addition, an assessment of a variety of hazard adjustments was made based on both child and parent report.

The design was quasi-experimental[17] with a control group. That is, it was a pre-test/post-test control group design. It was quasi-experimental in that it involved administration of the independent variable (i.e. the two different versions of the virtual reality scenario) to intact groups. Two groups and a control were involved. The

first was designated "Emergency Condition" (EC) and consisted of a virtual earthquake scenario inside a school classroom in the middle of a class, populated with full body behaviorally realistic avatars. The second condition involved EC supplemented with avatars digitized with explicit photorealistic faces resembling the ones of the usual co-students of the school children. The groups were mixed with children that had experienced a medium earthquake before and children that had not. In this study, four classrooms from three different regions of the country were assigned to the EC Condition (n= 104), and four classrooms to the familiar faces, FF Condition (n= 105). Participants were from intermediate schools. Of the 209 total participants, 95 were female, 86 were male. The ages of the children ranged from 11 to 13 years (mean age = 11.8; SD= 0.45; modal age = 12).

The virtual environment was constructed using a combination of tools including the WorldToolkit R6 from Sense8, the DI-Guy scenario from Boston Dynamics and the proFACE face modelling software from Famous3D. The hardware included an SGI dual processor platform, an InterTrax2 (serial) head tracker and the i-visor DH-4400VPD (stereo) head mounted display. The overall performance of the system was in real-time (35fps) We also measured the biopsychobehavioral corollaries in real time with a Vienna Test System to associate the children's psychosocial and physiological responses.

2.2. Measures

Measures included self-report indices, the virtual scenario, and a home-based instrument filled out by parents after the treatment.

2.2.1. Self-Report General Self-efficacy measures

Participants completed a questionnaire that included both problem- and emotion-focused factors across a range of hazards and mass emergencies: floods, storms with high winds (e.g. cyclones), fires, earthquakes, volcanic eruptions, tsunamis, and chemical spills/gas leaks. Items intended to reflect problem-focused coping were assessed in three ways (child's knowledge about mitigation and response; child-reported hazard adjustments; parent-reported hazard adjustments). The items themselves were gathered from both emergency management/civil defence recommendations as well as previous research on hazard adjustments[18]. Other items were intended to reflect the youth's emotion-focused coping in three areas (hazard-related fear levels, perceptions of other's hazard-related distress, and perceptions of ability to cope emotionally with a future hazard). Each of these items, developed from previous research[24], has been linked to meaningful findings (e.g. with problem-focused coping; with reductions in problems following a hazard; responsiveness to intervention) as documented earlier: (1) prior to a hazard's occurrence as well as (2) in the aftermath of a hazard. Anxiety before and after the scenario was correlated with biopsychobehavioral during the scenario, using the State-Trait Anxiety Inventory (STAI) and the Vienna Test System.

We now provide an overview of each section of the virtual scenario. The following areas were assessed in addition to the data reported earlier with the questionnaire.

2.2.1.1. Problem-focused coping: Knowledge mitigation and response behaviours

Children were instructed that more than one item could be endorsed if it represented an appropriate response to that hazard. These items were adopted from those highlighted in Greek hazard education programs as well as emergency management brochures. The alpha reliability of these items using a larger sample (n= 548) from previous research was found to be 0.85.

2.2.1.2. Problem-focused coping: Hazard adjustments

Children were asked to follow the Drop, Cover and Hold drill adjustments, inside a virtual setting. The 23 specific adjustments included taking cover, storing hazardous materials safely, adding lips to shelves, having a fire extinguisher, having a smoke detector, storing emergency equipment, picking a contact person, learning how to administer first aid, finding out which hazards are more likely in their area, and having the school inspected for resistance to earthquakes. The alpha reliability here based on a larger sample (n= 557) used in previous research was found to be 0.92.

2.2.1.3. Emotion-focused coping factors

The items were as follows: (1) the child's level of overall fear or upset when encountering virtual hazards (1 = not at all, 2 = sometimes, 3 = often), (2) the child's perceptions of any co-student's upset when discussing hazards (1 = yes, 2 = not sure, 3 = no). These items were taken from a 10-item scale used in previous research that also assessed fears for eight specific hazards. The alpha reliability of that 10-item measure based on a larger sample (n= 405) was found to be 0.76. These two items were chosen for this research because they produced the most meaningful findings as reviewed earlier. A final item here was the child's perception of the ability to cope emotionally in the event of a hazard (1 = not at all able, to 7 = completely able to "to help self feel comfortable/less upset"). This was a stand-alone item that was based on previous research reviewed earlier. A previous three-item version used in research following a hazard (n= 118) reported an alpha of 0.71.

2.2.2. Home-Based Child Preparedness Questionnaire

This questionnaire asked, like the Mulilis-Lippa Preparedness Scale[3], for the capability in coping with the disruption associated with hazard activity. It was included, like the other measures, both before and after the virtual earthquake distress programs to assess intervention effectiveness. It also was included to provide a validity check of child reports. Our previous research assessed the correlation between child and significant other's report to be r= 0.30, p< 0.01. The alpha reliability of the measure based on a larger sample (n= 280) used in that previous research was found to be 0.77.

2.3. Procedure

The study was administered at pre-, during, and post-intervention within each of the schools by a trained doctoral-level child researcher (senior author) with the assistance of classroom teachers. Children were able to fill out questionnaires by reading to themselves after the instructions were read aloud to them. Children were then encouraged to enter the virtual scenario individually. Total time necessary to administer the scenario was approximately 5-6 minutes. As part of a post intervention homework exercise, children were asked to take a home-based questionnaire to their parents/guardians to have it filled out and returned.

2.3.1. Emergency condition (EC)

This condition involved a Virtual Reality Environment (VRE) around an existing Greek classroom of a school interior and part of the exterior. The VRML model of the school was photorealistic and imported directly, as a scale and layout reference. The classroom was populated with 12 students and a teacher, each capable of realistic emotive responses to an earthquake situation, such as show fear, communicate distress to varying degrees, move around the classroom. We provided two basic modes of interaction – a guided "storytelling" mode and an interactive mode, where the participant controls his or her navigation/actions in a simulated earthquake. When an earthquake event is triggered, avatars respond appropriately, items in the VE respond with some degree of physics, and the environment shakes along with the appropriate sound effects. The participant must evacuate the classroom and go to an exterior area, with visible and audible navigation cues if they deviate from the optimal path. The software was integrated with an InterTrax12 tracker and the researcher was using an interface (Vienna Test System) that allowed him to observe the participant's actions and biopsychobehavioral corollaries as he navigated through the VRE during the exercise.

2.3.2. Familiar Faces (FF) condition

This condition involved the EC plus a realistic representation of the co-students' faces, enhanced with emotional reactions in real-time. This focused on emotional factors and intentions to seek information explicitly; it was thought that a focus on the social self-image, psychological preparation and related fears would increase a sense of control and consequently benefit emotional factors.

2.4. Plan of Analysis, Assumption Checking, and Intervention Fidelity

Prior to assessing intervention effectiveness, differences between groups on each dependent variable were assessed. Given our focus on

outcome analysis, intervention effectiveness was assessed through a 2x2 split plot repeated measures analyses of variance (ANOVA). All necessary assumptions (homogeneity of variance, sphericity, homogeneity of covariance matrices, or intercorrelations) were met for these analyses with one exception. That is, the homogeneity of variance assumption was mildly violated between groups for pre-test fear scores (Levene's test, $F(1, 138) = 5.38$, $p < 0.03$). Various transformations (logarithmic, square, square root, reciprocal, arcsine) did not improve the homogeneity of variance estimate. However, given similarly shaped distributions, the variances being no more than four times different from each other (different by a factor of 1.3), and nearly equal sample sizes (difference of only six participants per cell in this analysis), the ANOVA procedure is generally robust under these conditions[18]. However, as an additional confirmation, an independent samples *t*-test was carried out on pre/post change scores (and, for the trials effect, a paired *t*-test for pre/post scores). Here, the homogeneity of variance assumption was met ($F(1, 138) < 1$), and the findings reflected the same statistics (when *t* scores were compared with *F* test scores based on *F* statistic, figures were within 0.007 of each other for between group and within 0.0004 for within group) and pattern of significance (within 0.001 of each other). Therefore, ANOVA findings were retained and are reported in Results.

Analysis of covariance (ANCOVA) and other forms of statistical control (e.g. hierarchical linear modelling (HLM)) were considered. However, in addition to the assumptions for ANOVA, ANCOVA requires the assumption of homogeneity of regression. In fact, this assumption is quite critical and, if not met, has been shown to lead to "misleading analyses" in relation to education programs[19]. In inspecting the scatter plots (using pre-treatment scores as covariates) regression lines were not uniformly similar in slope across parameters, thus making results from ANCOVA potentially suspect. However, as an exploratory device, ANCOVA was carried out and results were uniformly equivalent to those reported from ANOVA in Results (i.e. same pattern of significance). In terms of effect size (ES) comparisons, generally they were quite similar. However, when they differed, the ES estimated from the ANOVA was always more conservative than that from the ANCOVA.

In terms of HLM analyses, while children were nested within the classroom, given that the unit of generalization here was the individual child[20], the decision was made *a priori* (i.e. prior to the study commencing) to consider the classrooms within treatment condition as equivalent. This decision follows the convention, particularly in treatment outcome research in evaluating the initial effectiveness of an intervention[21], which uses as the basic unit of analysis the individual child. This is done despite the fact that in such studies typically each child is assigned to a different therapist (equivalent to the teacher/classroom here) within a particular intervention condition. The rationale for such a decision relates to the idea of intervention fidelity (i.e. equivalence in producing the named independent variable despite some individual variation on other factors). Given that we had confirmation from each teacher (and as a validity check, their overall supervisors for this project, the vice-principal and lead teacher) that the protocols described earlier followed improved confidence in using the more basic repeated measures analysis. Additionally, in terms of a rationale for HLM, we had, as recommended[22], no *a priori* data collected (e.g. teacher competence, systematic student differences by classroom) that spoke to what might underlie variability among the classrooms if an HLM procedure uncovered differences. Related to this idea, moderating or mediating influences were not considered as a primary focus of this study. Finally, recent recommendations regarding HLM have suggested a minimum number of groups necessary for valid HLM analyses to be much greater (e.g., 30-100) than the number of classrooms involved in this study (i.e. eight).

However, to provide a preliminary assessment of relationships between variables in the study, included is a zero-order correlation matrix. The variables in the correlation analysis not only included dependent (problem- and emotion-focused factors, pre-, post-, and change scores) and independent (intervention condition dummy coded) variables, but also other factors that were assessed, including age, sex, previous disaster experience, and classroom.

In the repeated measures analyses, both problem-focused factors (child- and survivors-reported hazard adjustments; child hazard knowledge) and emotion-focused factors (fear,

relaxed effect that comes as a result of stroking a dog for a long time is not felt when interacting with AIBO.

In this paper, we used seal robots to assist the activity of elderly people at a health service facility for the aged in order to investigate the psychological and social effects of the seal robots on the elderly people who stayed at the facility. We also compared the effects of the seal robot and those of a placebo seal robot that had a less active motion generation program.

SEAL ROBOT AND PLACEBO SEAL ROBOT

Specifications of Seal Robot

A seal robot, Paro, was developed for physical interaction with human beings (Figure 4). Paro looks like a baby harp seal, which has white fur for three weeks after its birth. As for perception, Paro has tactile, visual, auditory, and posture sensors beneath its artificial soft, white fur. In order for Paro to have a soft body, a tactile sensor was developed and implemented. As for action, Paro has seven actuators: two for each eyelid, two for the neck, one for each front fin, and one for the two rear fins. Paro weighs about 3.0 kg.

Paro has a behavior generation system that consists of two hierarchical layers of processing: proactive and reactive processes (Figure 9). These two layers generate three kinds of behaviors: proactive, reactive, and physiological behaviors.

(1) Proactive Behaviors: Paro has two layers to generate its proactive behaviors: a behavior-planning layer and a behavior-generation layer. Considering internal states, stimuli, desires, and a rhythm, Paro generates proactive behaviors.

(a) Behavior planning layer: This has a state transition network based on internal states of Paro and Paro's desire produced by its internal rhythm. Paro has internal states that can be named with words of emotions. Each state has a numerical level and is changed by stimulation. The state decays with time. Interaction changes its internal states and creates Paro's character. The behavior-planning layer sends basic behavioral patterns to behavior-generation layer. The basic behavioral patterns include some poses and some motions. Here, although "proactive" is referred, Paro's proactive behaviors are very primitive compared with those of human beings. We implemented behaviors similar to that of a real seal in Paro.

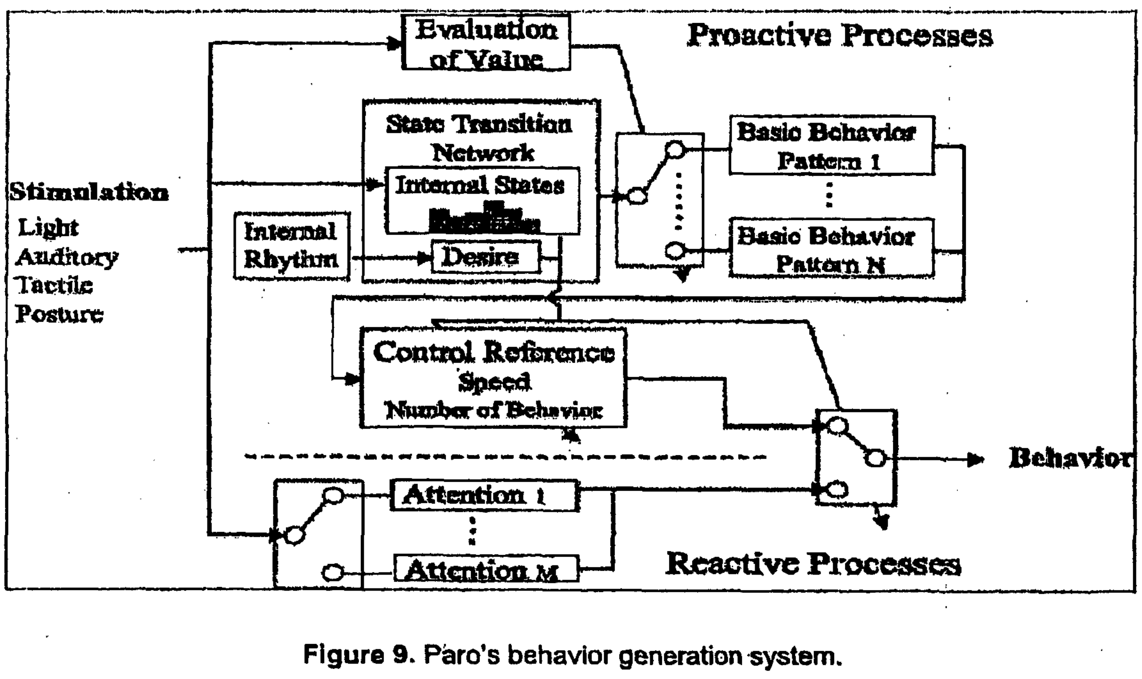

Figure 9. Paro's behavior generation system.

focused variables: (1) emotion-based hazard adjustments as reported by both children and survivors and (2) fear-related cope. These findings support previous corollary research[3, 10] and provide the first experimental evidence of the benefits of such programs prior to a hazardous event. It also follows similar research supporting the effectiveness of school-based intervention following a natural hazard[24].

Compared to the EC virtual scenario program, the FF Condition was seen to produce greater benefits in the areas targeted (i.e. problem-focused areas) and the emotion-focused area (i.e. hazard fears, perception of parental fears, emotional coping). What makes this finding particularly encouraging is that previous research following a disaster has found that those children coping less effectively perceived significantly greater levels of co-students distress[25]. The implication here, supported by additional corollary findings discussed below, is that the perception of decreased co-students upset likely has benefits for many children. In addition, the fact that these virtual programs were seen to produce a decreased sense of distress bodes well for these children being able to manage a future event more effectively.

While the FF Condition outperformed the EC Condition in the emotion-focused areas, the EC Condition nonetheless produced benefits as indicated by the large trials effects and related effect sizes, particularly in the area of both child- and survivors problem-focused reported hazard adjustments. Those findings here support our previous corollary research[24] and provide additional evidence supporting the general idea of increasing any children's exposure to hazards and disasters in educational settings.
In terms of relationships between variables in the study, a few are worth highlighting. First, there were no robust relationships seen between problem- and emotion-focused factors. However, there were relationships seen involving variables within a given domain (i.e. problem- or emotion-focused domains). In particular, problem-focused factors tended to relate to each other. For example, child factual knowledge was seen to relate to both child- and survivor-reported hazard adjustments. Fewer systematic relationships were seen within the emotion-focused domain. However, children's perception of co-student upset was seen to predict their own level of fear, measured with the Vienna Test System. The finding here provides some further support for the idea suggested earlier that children's perceptions of co-students' feelings affect their own fear levels.

Given that youth necessarily rely on adults or co-students for coping with problems, virtual adults' or co-students' willingness to react on such events may serve to help reassure children as well as provide them with a "coping model"[24]. Cognitive behaviour therapy is regarded as a brief form of psychotherapy, but it may not be brief enough in post disaster cognitive behaviour therapy settings, where hundreds of thousands of survivors may need urgent care. The virtual scenario modified with familiar faces presented here appears to be promising as an effective one- or two-session intervention for earthquake preparedness and survivors. It may be particularly useful in large-scale disasters as a cost-effective treatment that can be relatively easily disseminated to the masses.

Nonetheless, future research might include an after an earthquake condition to emphasize internal validity. Additionally, this study focused on short-term effects of virtual reality programs: future efforts might include follow-up assessments over a longer interval to assess whether changes are generalized across time. Finally, additional, *a priori* emphasis on specific nesting factors (e.g. schools, classrooms, families, intervention condition) and, related, potential mediators and moderators of change (e.g. demographic factors, child and family pre-intervention expectancies, teacher competence at program delivery) would begin to build on the initial foundation provided here.

	EC Condition	FF Condition	ANOVA Summary
Hazard Adjustments: Child			
Pre	5.83 (5.28)	7.00 (5.60)	a, b
Post	11.23 (6.10)	10.07 (6.50)	
Hazard Adjustments: Survivor			
Pre	10.25 (3.96)	9.94 (3.94)	a, b
Post	14.68 (3.96)	13.41 (3.87)	
Emotion-Focused Factors			
Hazard-Related Fears			
Pre	1.62 (0.57)	1.66 (0.48)	a, c
Post	1.55 (0.58)	1.54 (0.53)	
Perceptions of Co-students Distress			
Pre	2.19 (0.49)	2.17 (0.45)	a, c
Post	2.23 (0.56)	2.34 (0.48)	
Perceived Emotional Coping			
Pre	4.24 (1.61)	4.30 (1.49)	d
Post	4.21 (1.72)	4.21 (1.64)	
Note: EC = Emergency Condition; FF = Familiar Faces Conditions; subscripts denote the following based on analysis of variance (ANOVA), a = trials (time) effect significant; b = interaction effect significant (i.e., changes across time by group differed); c = interaction effect nonsignificant; d = trials and interaction both nonsignificant (*n* ranged from 140 to 216 in the analyses).			

Table 1: Problem- and Emotion-Focused Factors: Means (and Standard Deviations) and ANOVA Summary

Table 2: Zero-Order Correlation Matrix

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}
X_1	1.00																
X_2	−0.06	1.00															
X_3	−0.11	0.05	1.00														
X_4	0.10	0.13	−0.15*	1.00													
X_5	−0.09	0.02	−0.10	−0.14*	1.00												
X_6	0.03	−0.08	−0.25**	−0.12	−0.25**	1.00											
X_7	0.14	−0.00	−0.03	0.03	0.04	−0.19**	1.00										
X_8	0.13	−0.03	0.10	0.14	0.11	−0.13	−0.04	1.00									
X_9	0.01	0.05	−0.05	−0.05	0.07	0.05	0.06	−0.10	1.00								
X_{10}	0.09	0.00	0.02	0.02	0.03	0.03	−0.14	0.11	−0.03	1.00							
X_{11}	0.18*	0.01	0.21**	−0.10	0.08	−0.11	0.12	0.56**	−0.32**	0.12	1.00						
X_{12}	−0.05	−0.03	0.00	0.08	−0.15*	0.15*	−0.18*	−0.18*	0.26**	0.01	−0.24**	1.00					
X_{13}	0.09	0.09	0.12	−0.05	0.20**	−0.06	0.00	0.01	0.00	0.41**	0.15	0.01	1.00				
X_{14}	0.08	−0.06	0.11	−0.00	−0.02	0.31**	−0.05	−0.00	0.03	0.04	−0.16*	0.22**	0.03	1.00			
X_{15}	0.04	−0.04	0.13	−0.17*	−0.05	0.07	−0.05	0.05	0.05	0.11	0.14	−0.11	0.19*	0.30**	1.00		
X_{16}	0.09	−0.05	0.03	0.05	−0.04	0.43**	−0.01	−0.07	−0.03	0.11	−0.10	0.18*	−0.07	0.60**	0.07	1.00	
X_{17}	−0.08	−0.07	0.13*	0.02	0.07	0.29**	0.04	0.00	0.03	−0.01	−0.01	0.06	0.12	0.68**	0.28**	0.46**	1.00
X_{18}	−0.08	−0.04	0.10	−0.02	0.10	0.05	−0.04	0.06	0.09	0.03	0.09	−0.01	0.14	0.27**	0.72**	0.15*	0.52**
X_{19}	−0.04	−0.02	0.06	−0.09	0.03	0.35**	0.01	−0.11	0.05	0.01	−0.07	0.10	0.08	0.38**	−0.04	0.60**	0.61**
X_{20}	−0.16*	−0.01	0.05	0.05	0.11	0.04	0.15*	0.01	0.01	−0.05	0.14	−0.19*	0.08	−0.24**	−0.04	−0.06	0.55**
X_{21}	−0.10	0.05	−0.03	0.06	0.13	−0.18*	0.02	0.04	0.04	−0.16	0.07	0.10	−0.07	−0.11	−0.37**	−0.12	0.13

X_{22}	−0.11	0.01	0.02	−0.15*	0.08	−0.00	0.03	−0.06	0.07	−0.07	0.06	−0.08	0.15*	−0.14*	−0.11.	−0.28**	0.27**
X_{23}	−0.03	0.02	0.11	−0.24**	0.00	0.00	0.13	−0.42**	−0.22**	−0.02	0.51**	−0.11	0.05	−0.09	0.09	0.07	0.05
X_{24}	−0.08	−0.10	−0.01	0.12	−0.17*	0.13	−0.24**	−0.05	−0.55**	0.02	0.00	0.66**	0.01	0.13	−0.15	0.12	0.03
X_{25}	0.01	0.07	0.09	−0.02	0.15	−0.09	0.07	−0.09	−0.00	−0.49**	−0.04	−0.01	0.60**	0.10	0.10	−0.08	0.20*
X_{26}	−0.04	−0.02	0.02	0.01	0.13*	−0.14*	0.02	−0.06	0.05	−0.02	−0.05	−0.09	−0.01	−0.10	−0.01	−0.05	0.10
X_{27}	−0.02	−0.11	−0.05	−0.02	0.06	0.00	−0.03	−0.11	0.10	−0.16*	−0.10	0.12	0.00	0.04	−0.05	0.11	0.12
X_{28}	−0.02	0.01	0.05	−0.10	0.00	0.05	0.08	0.06	0.01	−0.05	0.06	−0.08	−0.10	−0.02	0.07	−0.08	−0.02
X_{29}	−0.09	0.08	0.04	0.13	0.02	−0.10	−0.01	0.01	−0.05	0.15	0.13	−0.05	0.09	−0.16*	−0.09	−0.04	−0.00
X_{30}	0.07	−0.02	−0.01	0.00	0.11	−0.15*	−0.01	−0.04	0.01	0.04	−0.13	−0.18	−0.01	0.00	0.05	−0.06	0.06
X_{31}	−0.05	0.10	−0.10	0.23**	−0.00	−0.25**	0.10	0.10	−0.03	−0.09	−0.09	0.07	−0.03	−0.10	−0.10	−0.13	−0.24**
X_{32}	0.04	−0.05	0.00	−0.07	0.01	0.09	−0.07	0.18*	−0.02	0.00	0.16*	−0.02	−0.03	0.04	0.14	−0.12	0.03
X_{33}	0.11	0.05	−0.05	−0.07	−0.02	0.12	0.01	−0.10	0.06	0.03	0.09	0.10	−0.01	−0.06	−0.14	−0.02	−0.15*
X_{34}	−0.04	−0.03	0.11	−0.10	−0.19**	0.25**	−0.07	−0.08	−0.08	0.07	−0.11	0.01	0.07	0.27**	0.09	0.35**	0.20**

X_{18}	1.00										
X_{19}	0.18**	1.00									
X_{20}	0.35**	0.37**	1.00								
X_{21}	0.38**	−0.02	0.31**	1.00							
X_{22}	0.06	0.60**	0.51**	0.09	1.00						
X_{23}	0.00	0.06	0.12	0.02	0.01	1.00					
X_{24}	−0.06	0.03	−0.13	0.09	−0.04	0.06	1.00				
X_{25}	0.10	0.06	0.09	0.06	0.17	0.07	−0.01	1.00			
X_{26}	0.07	0.11	0.24**	0.17*	0.18**	0.05	−0.11	0.02	1.00		
X_{27}	0.05	0.19**	0.12	−0.01	0.11	0.05	0.02	0.18*	0.34**	1.00	
X_{28}	−0.00	0.09	−0.01	0.08	0.19**	0.02	−0.13	−0.08	0.36**	−0.14*	1.00

X_{29}	0.07	−0.13	0.18**	0.24**	−0.10	0.11	0.03	−0.02	0.39**	−0.15*	−0.16*	1.00					
X_{30}	−0.01	0.03	0.07	−0.06	0.09	−0.11	−0.10	−0.07	0.39**	−0.15*	−0.16*	−0.17*	1.00				
X_{31}	−0.06	−0.26**	−0.18**	0.07	−0.18**	−0.24**	0.05	0.09	−0.37**	−0.13	−0.13*	−0.14*	−0.14*	1.00			
X_{32}	0.00	−0.19**	−0.03	−0.17*	−0.10	0.07	0.04	−0.05	−0.39**	−0.14*	−0.14*	−0.15*	−0.15*	−0.13*	1.00		
X_{33}	−0.13	−0.01	−0.13*	−0.00	−0.00	0.06	0.04	−0.06	−0.39**	−0.14*	−0.14*	−0.15*	−0.15*	−0.13*	−0.14*	1.00	
X_{34}	0.08	0.28**	−0.05	−0.13	−0.01	−0.03	0.04	0.02	−0.39**	−0.13*	−0.14*	−0.15*	−0.15*	−0.13	−0.14*	−0.14*	1.00

X_1= sex; X_2= age; X_3= social status; X_4= Thessalonica; X_5= Athens; X_6= Kozani; X_7= Ethnic — Other; X_8= pre-fear score; X_9= pre-others upset; X_{10}= pre-coping; X_{11}= post-fear score; X_{12}= post-others upset; X_{13}= post-coping; X_{14}= pre-child report — hazard adjustments; X_{15}= STAI score — hazard adjustments; X_{16}= pre-knowledge; X_{17}= post-child hazard adjustments; X_{18}= post-survivor hazard adjustments; X_{19}= post-knowledge; X_{20}= child adjustments post-pre change score; X_{21}= survivor adjustments post-pre change score; X_{22}= knowledge post-pre change score; X_{23}= fear post-pre change score; X_{24}= co-studentt perception post-pre change score; X_{25}= coping post-pre change score; X_{26}= intervention group (0 = EC, 1 = FF); X_{27}= Room EC 1; X_{28}= Room EC 2; X_{29}= Room EC 3; X_{30}= Room EC 4; X_{31}= Room FF 1; X_{32}= Room FF 2; X_{33}= Room FF 3; X_{34}= Room FF 4 (*n* ranged from 140 to 219); $^*p < 0.05$, $^{**}p < 0.01$ (two tailed).

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Training Brief Intervention with a Virtual Coach and Virtual Patients

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Abstract: *Alcohol and substance abuse is the number one mental health problem in America as well as a major health problem. Although brief interventions during primary care visits can be effective, clinicians usually do not act on signs of alcohol abuse—often because they do not know how to intervene. Clinicians need training in brief intervention techniques, but this is impractical due to the large number of clinicians, the high costs, and the daunting logistics of the only effective training method currently available—practice with standardized patients. To address this need, we developed STAR™ Workshop, an online training workshop incorporating a virtual coach and virtual standardized patients. The STAR coach motivates and teaches an evidence-based brief intervention protocol. STAR virtual patients provide practice and intrinsic reinforcement. After each practice session, the coach offers additional feedback and any needed remediation. We comparatively evaluated STAR Workshop against a self-paced E-Book covering the same content and a no-training Control, with medical and nursing students as subjects. Subjects trained with STAR Workshop substantially outperformed subjects in the other conditions, achieving high scores on self-assessments of their own intervention skills and intentions to intervene, as well as on objective assessments of their intervention skills, based on both short-answer probes and recorded interventions with live standardized patients. Thus, STAR Workshop provides a scalable, affordable, and effective approach to training brief intervention skill in alcohol abuse.*

INTRODUCTION:

Alcohol and substance abuse is the number one mental health problem in America and a major health problem, impacting individuals, families, friends, co-workers, employers, and communities. Brief interventions administered during routine clinic visits have been shown to be effective in reducing the health risks and social costs of alcohol abuse[1-4]. Primary care settings are ideally suited for intervention, as patients tend to visit them more often than medical specialty settings[5]. Brief interventions are also attractive for their simplicity and low cost. Following a simple 10-15 minute interview protocol, non-specialists can effectively administer brief interventions[6].

Unfortunately, few providers routinely screen patients or intervene in alcohol abuse. Fleming[26] reports 20% screening rates during hospital admissions, citing insufficient training as the primary reason: "Asking patients about sensitive life-style issues, such as alcohol use, requires strong communication skills. Many physicians have not received training in this area." The Center for Addiction and Substance Abuse (CASA) finds that physicians miss signs of alcohol abuse 94% of the time and 11% of patients report physicians who were aware of their addictions, but did nothing[7]. Calling alcohol and substance abuse America's #1 disease, Joseph Califano, President of CASA and former Secretary of HEW, said, "Substance abuse is an elephant in the examining room. Doctors may simply be embarrassed to ask the key questions. They don't want to anger their patients. They think patients will lie about this... Medical schools and other education programs for physicians need to provide more training on how to spot and deal with substance abuse." A Commonwealth report on medical education[8] concurs: "Many young physicians do not feel confident counseling patients on such subjects as smoking, weight reduction, safe sex practices, domestic violence and drug and alcohol use. To prepare students for the challenges facing health care in the 21st century, academic health

centers must place more emphasis on skills traditionally not taught in medical schools. Physicians need training to address the behaviors and social circumstances at the root of many health care issues."

For inter-personal skills such as those involved in brief intervention, role-playing has long been recognized as the training method of choice[9]. Roughly 80% of medical training centers now integrate role-play with "standardized patients" as part of a problem-based medical curriculum[8,10]. More specifically Fleming[26] suggests that "Role playing can be an invaluable way to teach physicians how to become more comfortable with alcohol screening questions and interviewing techniques allowing them to rehearse their skills before they interact with their patients. Because nothing can substitute for practice and repetitions, role playing can build a physician's confidence in his or her alcohol-screening skills."

On the other hand, cost and logistics make this approach impractical. It takes 10-30 times as many teaching professionals to move from a traditional, lecture-based model to small group instruction of 5-10 students in problem-based curricula. Many smaller community teaching hospitals do not have the resources to implement problem-based curricula and few teachers have expertise in conducting small groups[8]. The use of standardized patients is also expensive. The Uniformed Services University, one of the largest military medical training centers in the country, reports annual operating costs for its Medical Simulation center at of $1.3 million with $300,000 for standardized patients and $125,000 in training costs[11]. The American Medical Association estimates the cost of clinical skills testing with standardized patients as high as $1,700 per test[12]. Similarly, test preparation companies are charging approximately $1,000 per day for small group workshops with standardized patients.

Moreover, even live workshops and role-plays appear to have limited efficacy. In our own studies of inter-personal skills for management-staff communication (which are in many ways analogous to brief intervention skills), live training workshops featuring professional instructors and peer role-players produced high learner satisfaction and self-reports of skills improvement, but little or no improvement on objective performance measures[13]. Similarly, in several studies of motivational interviewing for alcohol abuse, live training workshops produced self-reports of skills improvement up to 4 months later, but only modest improvements (too small to affect client response) in objective observations of interviewing performance[14-16].

We believe that these disappointing results reflect common misconceptions about the nature of sophisticated inter-personal skills and the training experiences required for individuals to master such skills and incorporate them into everyday practice. First, many people underestimate the high skill levels required for efficacy in sensitive inter-personal interactions and the amounts of practice and coaching required to attain skill levels. Compounding this misconception, many people suffer "cognitive illusions" in which they overestimate the efficacy of unchallenging training experiences and the skills they engender[17]. Third, instructors and standardized patients vary in their own expertise and consistency. After all, they are only human! In sum, we believe that even expert researchers and training providers err in attempting to achieve ambitious training objectives—mastery of sophisticated inter-personal skills—by providing an insufficient amount of insufficiently challenging, variable-quality training experience.

To address the need for effective, efficient, affordable, scalable training in brief intervention skills, we developed *STAR™ Workshop for Brief Intervention in Alcohol Abuse*[18]. Following the literature on enhancing human performance[17, 19], STAR Workshop implements a *Guided Mastery*™ pedagogical strategy, featuring a virtual coach and several virtual standardized patients (VSPs), all built on *interactive character technology*[20-22]. Figure 1 displays excerpts from a training session in STAR Workshop.

Like live workshops with standardized patients, STAR Workshop provides expert instruction, authentic practice, and detailed feedback. In contrast to live workshops, STAR's Guided Mastery strategy provides as much practice and as much coaching as each individual learner requires, systematic guidance to mastery of target skills, and individually optimized learning paths. Thus, in addition to being affordable and scalable, we hypothesize that STAR Workshop will be

uniquely effective and efficient in its training of brief intervention skills. The present study is designed to evaluate that hypothesis.

MATERIALS AND METHODS:

Target Protocol. To provide a training target for our study, we developed a brief intervention protocol called *Engage for Change™ (E4C™).* The E4C protocol adapts the evidence-based techniques of motivational interviewing[15]. Given the practical needs of a large and diverse population of primary-care clinicians, and the operational requirements of automating the training process, the E4C protocol also was constrained to be general, brief, memorable, teachable, and verifiable. At the most general level, the E4C protocol is as follows:

A. Inform the patient of health risks:

1. Raise the topic of alcohol consumption in a general health context.
2. Inform the patient of his or her specific health risks associated with alcohol.

B. Acknowledge the patient's point of view:

3. Invite the patient to express his or her concerns about health consequences of alcohol
4. Accept the patient's stated concerns.

C. Encourage the patient to make a change.

5. Invite the patient to make an appropriate change step.
6. Ask the patient to commit to make the change step.

Motivational interviewing was developed originally as a compassionate alternative to confrontational methods for treating addiction. Its efficacy is supported by many studies, including studies of intervention in alcohol abuse in particular [2,14,23,24]. Thus, the E4C protocol should be similarly effective for brief intervention in the abuse of alcohol. However, verification of its clinical efficacy is beyond the scope of this study.

Instructional Content. We created 41 Web pages containing 23 pages of instructional content for use with all learners; 12 pages of coaching content to be used with individual learners at the coach's discretion; and 6 pages for displaying VSP medical histories and role-play scores.

Virtual Coach. We created a virtual coach named "Harmony." She has an animated embodiment with ~25 gestures and facial expressions, which she uses to complement her dialogue. She delivers her dialogue in a synthesized voice and typed speech bubbles, personalizing it to call the student by name, quote segments of the student's role play conversations with VSPs, etc. Harmony presents 80 instructional topics, with ~100 associated lines of instructional dialog. She also has ~300 lines of feedback dialogue which she selects and instantiates with student-specific information. She has ~100 lines of coaching dialogue, which she selects based on student performance. She has 124 preconditions, which she uses to select dialogue and actions. Harmony currently accepts only point-and-click input from students wishing to continue or quit.

Virtual Standardized Patients. We created 3 VSPs—Lee, Nina, and Ed—differing in gender, age, culture, personality, health scenario, resistance, and referral needs. Each VSP has a photographic embodiment (created with actors), with ~25 gestures and facial expressions, which he or she uses to complement dialogue. VSPs deliver their dialogue in recorded human voice (created by actors) and typed speech bubbles. They accept typed natural language input from students. Each VSP has 12 conversational contexts, with ~200 lines of dialogue and 2-6 alternate wordings for each line. They recognize 80 sets of semantically equivalent student inputs, with 8-20,000 alternate wordings accepted for each one. VSPs have 75 preconditions, which they use to select dialogue, gestures, or a new conversation context. They have 18 moods (e.g., confident, unconfident, edgy, defensive, comfortable), which are influenced by their interaction with a student and manifest in the selection of dialogue, gesture, and context.

Training Conditions. Our study had 3 training conditions: STAR Workshop, E-Book, and Control. STAR Workshop is described above and incorporates all instructional content, the virtual

coach, and the 4 VSPs. For E-Book, we created a self-paced course, with Web pages incorporating all instructional content created for STAR Workshop, plus all of the STAR Coach's instructional dialogue. Students could access the E-Book like a conventional e-learning application, choosing whether or not to follow the recommended page sequence, how much time to spend on each page, etc. The Control condition had no training.

Subjects. 31 subjects included medical students from Stanford University and nursing students from the University of San Francisco and San Jose State University. We assigned subjects to training conditions semi-randomly, balancing education, age, gender, ethnicity, and pre-training assessments of attitudes and skills (discussed below). We did not predict or find any effects of these variables and do not refer to them further. Subjects were paid $100 for their participation.

Procedure. The following procedure was applied for all subjects:

- *Pre-Training Assessment* – Self-reports of attitudes and short-answer skills probes;
    - o *Training* – STAR Workshop or E-Book or Control
- *Post-Training Assessment* – Self-reports of attitudes and short-answer skills probes;
    - o *2 Week Post-Training Retention Interval*
- *Post-Delay Intervention with a Live Standardized Patient (LSP)* – Telephone interview
- *Post-Delay Assessment* – Self-reports of attitudes and short-answer skills probes.

Attitude Assessments. Subjects used 5-point Likert scales to report their attitudes toward these statements: *1. The E4C protocol is effective. 2. The E4C protocol is practical. 3. My training method was effective. 4. I am confident in my brief intervention skills. 5. I plan to intervene with patients who show signs of alcohol abuse.* For STAR and E-Book subjects, pre-training assessments included statements 4 and 5; post-training and post-delay assessments contained statements 1-4. For Control subjects, all assessments included only statements 4 and 5.

Efficacy–Skills Probes. Subjects' skills were assessed with short-answer probes, representing the 6 steps in the E4C protocol, on all 3 assessments. Responses were scored 0-3 points: correct step, correct step in context, no errors (e.g., patronize, contradict, advocate change).

> *Sample Basic Probe Item:* Troy, 43, an attorney, is at your clinic to check his recovery from a broken collarbone suffered in a car crash. On his medical history, he reports that he consumes 30 drinks of alcohol per week. He also reports frequent insomnia and gastritis, which you think may be related to his alcohol consumption. Troy says: "The shoulder's much better. We're done for today, right?" What do you say?
> *Correct response step:* Step 1. Raise the topic of alcohol consumption in a health context.
> *Sample correct responses:*
> "I would like to spend a few minutes explaining how drinking may be affecting your health."
> "Troy, I want to discuss the role of alcohol as a contributing factor to insomnia."
> "Let's talk about the how alcohol consumption may be contributing to your gastritis."

Note: Besides *basic probes*, our study included easier *cued probes* and more difficult *open probes*. Since all probes showed comparable effects, we discuss only basic probes here.

Transfer of Retained Skills—Live Intervention. Subjects' skills were assessed in performance of telephone interventions with a live standardized patient (LSP), conducted after the 2-week post-training retention interval. Subjects received the case history below and then were given 10 minutes to conduct the intervention. The recorded intervention was scored 0-18 points, with 0-3 points (correct step, correct step in context, no errors) for each step in the E4C protocol.

The LSP Case History. Morgan, 51, a recently divorced attorney and mother of 2, is at the clinic for an allergy shot. Her previous record indicates low-normal blood pressure and overall good health. On exam, her blood pressure is significantly higher than on previous exams. She has a slight cough today and reports that she is recovering from a cold. On her medical history, she reports drinking 2-3 glasses of wine daily. She has occasional headaches and moderate stress. According to NIAAA guidelines, a woman may be at risk for alcohol-related problems if she consumes more than 7 alcoholic drinks a week or more than 3 drinks a day. High blood pressure and headaches are both associated with heavy drinking. You are concerned that Morgan's alcohol use may be contributing to these conditions and that she may be headed for future health problems. You suspect that her drinking may be having negative impacts on other areas of her life, as well. An appropriate referral for Morgan might be to a behavioral health case manager to develop a reduction plan.

Scoring and Data Analysis. Two judges blindly and independently scored responses for skills probes and live interventions. An independent 3rd person combined judges' scores and entered them in spreadsheets along with self-report attitudinal data, key demographic data, and learning path data automatically recorded by STAR and e-Book. Summary statistics were computed in these spreadsheets. We omit conventional statistics; these would be redundant and obvious, given the large and consistent differences observed.

RESULTS:

Verifiable Individual Progress and Individually Optimized Training with STAR Workshop

100% of subjects in the STAR Workshop condition mastered the E4C protocol. Subjects displayed individual progress in performance improvements with successive VSPs: increasing initial role-play scores (means = 4, 14, 17 out of a perfect score of 18), decreasing number of role-plays required for mastery (means = 6, 3, 2), decreasing number of step-coaching events required for mastery (means = 14.3, 5.7, 2.8). In addition, 100% of STAR subjects were guided along unique learning paths, optimizing the sequence, duration, and content of instruction, role-play, feedback and coaching, based on individual progress and specific individual behaviors during role-play. As a consequence, subjects varied widely in the number of minutes they spent on: instruction (range = 15-23), role-play (range = 24-105), and coaching (range = 28-131).

Comparison of Immediate Impact and Efficacy of STAR, E-Book, and Control

STAR and E-Book produced comparable positive immediate impact on subjects' attitudes. Subjects judged the E4C protocol effective (mean = 5 vs. 5) and practical (mean = 4 vs. 4), They gave positive ratings to their training (mean = 4 vs. 4), their intervention skills (mean = 4.5 vs. 4.25), and their intentions to intervene with patients showing signs of abuse (mean = 5 vs. 4).

However, E-Book subjects performed only slightly better than Control (no training) subjects on skill probes of immediate efficacy. 72% vs. 62% of subjects improved over pre-training skills, achieving 22% vs. 10% of the maximum possible improvement. Subjects averaged 61% vs. 50% correct responses on post-training assessment, with no subjects in either group scoring >90%. Thus, E-Book subjects' positive self-assessments reflected over-confidence.

By contrast, STAR subjects performed substantially better than E-Book and Control subjects, and at a high absolute level, on skills probes of immediate efficacy. 100% of STAR subjects improved over pre-training skills, achieving 78% of the maximum possible improvement. STAR subjects averaged 89% correct responses on post-training assessment, with 46% scoring >90%. Thus STAR subjects' performance validated their positive self-assessments.

Comparison of Retained Impact and Efficacy of STAR, E-Book, and Control

Results for retained impact and efficacy, following the 2-week retention interval, were similar to but more exaggerated than results for immediate impact and efficacy.

Again, STAR and E-Book produced comparable positive retained impact on subjects' attitudes,

identical to the immediate data, except E-Book subjects reduced their mean assessment of the effectiveness of the E4C protocol from 5 to 4.

On skill probes of retained efficacy, E-Book subjects fell even closer to Control subjects, whose scores remained constant. 64% vs. 62% of subjects improved over pre-training skills, achieving 11% vs. 10% of the maximum possible improvement. Subjects averaged 56% vs. 50% correct responses on delayed skills probes, with no subjects in either group scoring >90%. Thus, after a 2-week retention interval, training with E-Book was no better than no training at all.

Again by contrast, STAR subjects performed substantially better than E-Book and Control subjects, and at a high absolute level, on skills probes of retained efficacy. 100% of STAR subjects improved over pre-training skills, achieving 78% of the maximum possible improvement. STAR subjects averaged 89% correct responses on delayed skills probes, with 55% scoring >90%. Thus STAR subjects retained their excellent skills over the 2-week retention interval.

Comparison of Transfer of Retained Skills to Live Intervention

On transfer to live intervention, E-Book scores were similar to Control scores. Subjects in both groups averaged 50% correct, with no subjects in either group scoring >90%. However, only 18% of E-Book subjects made no extraneous errors, compared to 38% of Control subjects. Again, training with E-Book is no better than no training at all.

STAR subjects performed substantially better than E-Book and Control subjects, and at a high absolute level, on transfer to live intervention. STAR subjects averaged 94% correct performance, with 55% scoring >90%, and 82% making no extraneous errors. In fact, these scores are at least as good as the scores on the immediate and delayed skills probes. Thus STAR Workshop prepared subjects to perform quite well in live interventions 2 weeks after training.

DISCUSSION:

Results of the present study demonstrate the efficacy of STAR Workshop for training clinicians in the E4C protocol for brief intervention in alcohol abuse. STAR subjects performed extremely well on both immediate and delayed skills probes and on the critical test of intervention with a live standardized patient. In addition, STAR subjects showed 100% uniqueness and broad variability of learning paths, tied to individual progress on learning objectives. Thus, the results confirm our hypothesis that STAR Workshop would provide effective and efficient training in brief intervention skills.

Results of the study also indicate that training with E-Book self-paced learning may induce cognitive illusions in which learners overestimate the efficacy of their training and their own competence. Although E-Book subjects reported high confidence, comparable to STAR subjects, their performance was poor and comparable to no-training Control subjects on all immediate and delayed skills probes, as well as on intervention with a live standardized patient.

Although this study did not include a live training condition, it is noteworthy that STAR subjects demonstrated very strong intervention skills on all assessments and especially on their interventions with a live standardized patient. With enhancements to STAR Workshop—for example, practice with a greater variety of VSPs—performance will approach a ceiling, leaving the possibility for only small improvements, at best, for live training. Given the high cost and daunting logistics of live training, STAR Workshop may offer an extremely attractive alternative, matching the efficacy of live training at a lower cost. While further study is required to clarify these cost-benefit trade-offs, the prospect of a *Pareto optimal* approach is tantalizing.

It also is worth noting that the E4C protocol is a *variable* in our study and in STAR Workshop. Although prior research on motivational interviewing suggests that E4C should be clinically effective for brief intervention in alcohol abuse, it is quite possible that new research might suggest improvements to the protocol or an alternative more effective protocol. STAR Workshop can be applied to teach any such new or modified protocol. In fact, STAR Workshop can be an important tool supporting large-scale clinical trials of alternative intervention protocols, by providing an efficient and effective means of verifiably training large numbers of clinicians to reliably follow experimental protocols.

In sum, the present findings provide a promising foundation for developing a comprehensive program for training brief intervention in alcohol abuse and delivering it to a broad range of primary-care clinicians in a form that is practical, scalable, and affordable. This would enable a larger number of clinicians to perform more effective interventions with a larger number and diversity of patients, at earlier, more treatable disease stages. This, in turn, would enhance immediate and life-long patient health, while reducing immediate and life-long costs of health care.

Success with this important application would also lay the groundwork for developing STAR Workshops to train effective intervention protocols for drug abuse, obesity, eating disorders, exercise, safe-sex, diabetes management, asthma management, and other conditions where health outcomes and costs depend on clinician skills for facilitating change in patient behavior.

Figure 1: Illustrative Excerpts from a Training Session in STAR Workshop.

Kay (pseudonym), a Stanford medical student, is learning the E4C protocol in STAR Workbench. Harmony, the STAR Coach, explains, motivates, and illustrates each step in the protocol.	Kay, when inviting your patient to express concerns, try to cultivate an atmosphere of trust and the patient's sense of autonomy. Be sure to ask an open-ended question that invites more than a yes or no answer. A patient who can speak freely may reveal a lot about motivation and readiness to change.  Step 3. Invite the patient to express concerns... **by asking open-ended questions that relate drinking behavior to health, work, social, or family consequences.** **Example:** ***"How do you think your use of alcohol may be affecting your health?"***
Lee, a VSP, gives Kay authentic practice, conversing with her in natural language, complemented by appropriate facial expressions, body language, and emotional dynamics. Lee's life-like behavior provides intrinsic reinforcement of Kay's performance. Even smart students like Kay make errors on early practice.	*Kay, a Stanford medical student (pseudonym), performs her 1st post-training role play practice with Lee, a virtual standardized patient (VSP)*  Lee: I really thought I had broken a bone. Kay: Lee, I would like to talk about how alcohol is affecting your health. Lee: OK, fine. Kay: You need to reduce your drinking, Lee. Lee: I don't know that I want to do that. Kay: Well, you should think about it. Lee: I didn't come here for a lecture. So, good-bye.
Harmony scores Kay's role-play performance. She offers detailed, personalized feedback, calling Kay by name and quoting segments of her dialogue with Lee. Harmony provides explicit, systematic reinforcement of strengths and weaknesses in Kay's intervention with Lee. For each step in the E4C protocol, Harmony explains what Lee did, whether or not it was correct, and what its consequences were.	Kay, that didn't go very well, did it? Don't worry. You can try again in a moment. Let's review. You did a good job raising the topic of Lee's drinking when you said, *"Lee, I would like to talk about how alcohol is affecting your health."* By raising the topic in a neutral health context, you made Lee feel comfortable and willing to discuss his drinking. Good work, Kay. Next, you should have informed Lee of his specific health risks associated with drinking. Instead, you suggested that Lee change his behavior, when you said, *"You need to reduce your drinking, Lee."* I know this was good medical advice, Kay. However, advocating change prematurely actually made Lee more resistant. ... *[etc.]*  nt — Scores 3/3 0/3 0/3 0/3 Encourage the Patient to Make a Change 5. Invite the patient to move towards change. 0/3 6. Encourage the patient to commit to the change. 0/3

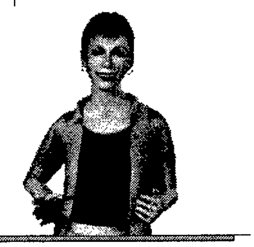
Harmony gives Kay remedial instruction only for those protocol steps on which she made errors in her most recent role-play practice.

Harmony suggests, motivates, and illustrates substitute behaviors for Kay to try in her next role-play practice.

Kay, informing your patient of risks associated with alcohol consumption is one of your
important functions.

Remember to tell your patient how drinki
impacts his or her specific health conditi

Your message will most likely be heard i
stick to the facts and refrain from criticizi
your patient's current drinking behavior c
advising a particular course of action.



Inform the patient of specific risks... by simply stating the relevant facts.

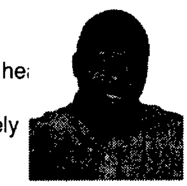
Example 1: "You have elevated blood pressure and gastritis. Alcohol can be a contributing factor to both of these conditions."

Example 2: "Drinking alcohol is associated with headaches and difficulty sleeping. I noticed that you have both of these problems."

Kay masters the E4C protocol on her 5th role-play with Lee.

Note that VSP Lee provides authentic repeat practice. He responds appropriately to changes in Kay's behavior and introduces normal variability in his own dialogue. Thus, Kay cannot simply remember a correct "script" for intervening with Lee. She must listen and engage expertly with Lee on every practice.

Kay's 5th role play with VSP Lee is perfect



Lee: Well, I'm relieved there's no fracture.
Kay: Let's discuss the impact of alcohol on your he
Lee: OK, fine.
Kay: Your alcohol consumption may be negatively affecting your ulcers, blood pressure, and sleep.
Lee: Well, that's certainly one of the downsides.
Kay: Lee, what effect do you think alcohol has on your health?
Lee: I hate having the ulcer! Drunks have ulcers. Believe me, I'm not getting any more drunk diseases!
Kay: You're worried that drinking is causing your ulcers.
Lee: To be honest, it's tougher to quit than I thought it would be.
Kay: I know a counselor that you might be interested in seeing. She's helped other young professionals like you change their drinking patterns.
Lee: Interesting.
Kay: Will you follow through with this referral?
Lee: All right. I'm going to do it. OK. Bye now. And thanks.

Coach Harmony congratulates Kay on her mastery of the E4C protocol with Lee. She systematically reinforces every element of Kay's correct performance.

Next, Harmony will introduce VSP Nina and, later, VSP Ed. With each of them, she will guide Kay through the same individualized process of practice-feedback-coaching, leading her to mastery of the E4C protocol.

Excellent Kay! You've mastered the role play with Lee. Let's review.

Another good start for you, Kay. You said, *"Let's discuss the impact of alcohol on yo health."* By introducing the topic in a hea context, you made Lee feel comfortable a willing to discuss his alcohol consumption

Kay, this is your best score so far on step You informed Lee of his specific health risks when you said, *"Your alcohol consumption may be negatively affecting your ulcers, blood pressure, and sleep."* Again, Kay, you did a good job inviting ... *[etc.]*

agement	Scores
	3/3
risks.	3/3
Acknowledge the Patient's Point of View	
3. Invite the patient to express concerns.	3/3
4. Accept the patient's stated concerns.	3/3
Encourage the Patient to Make a Change	
5. Invite the patient to move towards change.	3/3
6. Encourage the patient to commit to the change.	3/3

ACKNOWLEDGEMENTS:

We gratefully acknowledge expert consultation on design of the Engage for Change™ protocol and specification of practice cases for VSPs, from Dr. Nancy Handmaker, of the University of New Mexico, and Dr. Louis Moffett and Dr. Mathew Cordoba, of the Palo Alto Veterans Administration Medical Center. This projected was funded by grant 1 R43 AA014306-01 from the NIAAA. Technology development was funded by grant 70NANB9H3024 from the NIST ATP.

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Addiction to Massively Multiplayer Online Role-Playing Games

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Abstract: *As computer and Internet use become a staple of everyday life, the potential for overuse is introduced, which may lead to addiction. Applications such as online chat on Internet Relay Chat (IRC) and text based role-playing games on Multi-User Domains (MUDS) have been extremely popular for years. Research on internet addiction has shown these are the types of applications users become addicted to. Recently, these applications have evolved into graphically intense three dimensional virtual worlds called Massively Multiplayer Online Role-Playing Games (MMORPGs). Addiction to the Internet shares some of the negative aspects of substance addiction and has been shown to lead to consequences such as failing school as well as familial and relationship problems. The factors surrounding these cases must be examined from an HCI perspective as they pertain to both computer usage and the impact it has on its users.*

BACKGROUND

Internet addiction is not yet a DSM IV diagnosis, but its definition has been derived from DSM IV criteria for addiction and obsession. Young [18] coined the term "Internet Addiction Disorder" listing diagnostic criteria, which many researchers refer to as a starting point. Yet, there is no official DSM IV diagnosis, and because of this, researchers of Internet addiction form their own criteria for this disorder. Of those criteria, the two most referred to are substance abuse (addiction to chemicals) or behavioral obsessions and/or compulsions. There is an ongoing debate among psychologists on what distinguishes certain addictions from obsessive behaviors. A substance addiction is defined as something which you enjoy doing, or initially enjoyed, and eventually involves physical dependence. Researchers such as Young [18] replace the word "substance" with "Internet" in their analysis of Internet addiction, concluding that similar symptoms such as tolerance (needing more substance or Internet for satisfaction), withdrawal (a need for the substance or Internet when one does not have it available), craving (doing more of the substance or Internet and investing more time into it), and negative life consequences (job loss, family and social problems) are present in Internet addiction as well. An obsession can be described as ideas or thoughts that dominate a person's mind. Compulsions can be irresistible urges or repetitive behaviors (cleaning or checking something continually). It is a behavior often done in response to an obsession. Research done by Walker [14] would label Internet addiction an obsessive and compulsive behavior, based on its similarities to gambling addiction and compulsive shopping, since all of these disorders lack chemical dependence. Still, very little is known about Internet addiction as a whole.

Early research done by Shotton [12], who researched Internet addiction in the early 90's, concluded that addicted computer users were mainly male introverts. These men were highly educated, had an affinity for computers, and had a constant need for intellectual stimulation. However, that data is no longer relevant. A few years later, studies by Griffiths [4, 5], O'Reilly [9] and Young [15-18] reached drastically different conclusions. Their results revealed that dependent users were primarily middle-aged females on home computers [16] and anyone with internet access could become addicted [9]. This drastic shift has come about simply because there are more Internet-ready computers in homes now than in 1991. This is due to low costs and acceptance in our culture (businesses, mass media, and personal relationships all depend on the Internet). Through email (for business and personal use), chat (mainly personal communication) and the World Wide Web (businesses have embraced it and the near limitless amalgam of topics available

on it) the Internet has a niche for anyone who has the time to spend on it. Email, chat and the web are examples of applications used on the Internet whose nature has addictive properties [17]. Basically, the Internet itself is not addictive, but the services available on the Internet are. Young found that interactive "real time" services such as Internet Relay Chat (live chat with other IRC users in chat rooms, socializing and discussing common topics) and multi-user domains (MUDS – text based virtual worlds where users meet and explore, where social interaction is required) proved to be most addictive. The use of IRC was examined by Peris [11], and it was found that frequent users of IRC "find, in online chats, a media for rich, intense, and interesting experiences" while "they consider online relationships as real as face to face relationships". In another study by Moody [8], it was found that high internet use (on IRC or email) is associated with high emotional loneliness. Users will eventually spend all their time online and choose not to interact in real life physical social settings. Jacobson [6] researched MUDS users and found that "users participate in rewarding activities that allow them to use their skills and knowledge in the challenges of these virtual worlds" and "people become absorbed in the activities and relationships that occur in them". When examined as an addictive substance, applications such as IRC and MUDS can be used to "withdraw or escape from negative evaluations and the stress of interpersonal relationships" [2]. This results in loss of control over time spent on the Internet, leading to problems in school, relationships, finances, occupation, and health [17]. Users who tried to cut back the time they spent on the Internet to avoid these addiction-related problems could not. Even those who threw out their modems could not resist the urge of buying new modems to get back on the Internet [17]. Young concluded that users do become addicted and that there is a potential for more addictive applications in the future.

MUDS introduced interactive online role-playing games to the Internet, but as technology advanced, so did this genre of games. With the availability of 3D graphics in games, it became possible to build three dimensional (3D) visual representations of the once text-only MUDS. Now, users are able to see and interact with others in their 3D virtual worlds. These massively multiplayer online role playing games (MMORPG's), such as "Everquest", "Ultima Online" and "Diablo II" have been categorized as "heroinware" by many of its users, as they contain all of the addictive elements of IRC and MUDS. MMORPGs, which are run in real time, feature social and competitive aspects, making devotion to the game mandatory. If you are not playing online, you are probably falling behind. While traditional videogames end at some point or become repetitive and boring, MMORPGs are endless, because the main feature of MMORPGs is its system of goals and achievements. As you play, your character advances by gaining experience points "leveling up" from one level to the next, while collecting valuables and weapons - becoming wealthier and stronger. This system creates an online "life" for your character and if you die, the penalty is a deduction of experience points. Social interaction in MMORPGs is highly essential, as you must collaborate with other players in the game to succeed in more complex goals. Eventually, a player must join a "guild" or "clan" of other players to advance further in the game. Finding other players in the game "Everquest" is not hard, as there are 433,445 active players worldwide including the 12,000 new players every month, each paying $12-$40 a month for access to the game [13].

Everquest (or Evercrack, as many players have nicknamed it) is a fantasy game, based on concepts similar to the work of Tolkien's Middle Earth and Dungeons and Dragons, and is the most popular of all MMORPGs. Because of its popularity, Everquest has received the most press and the most blame for MMORPG addiction. In a recent News.com article [1], one recovering Everquest player was quoted, "The game almost ruined my life, it was my life. I ceased being me; I became Madrid, the Great Shaman of the North. Thinking of it now, I almost cringe; it's so sad." The same article describes players who have lost their jobs and even marriages due to overuse of Everquest. Another player explained his addiction, "I'd say the most addictive part for me was definitely the gain of power and status, the way in which as you progressively gain power you become more of an object of awe to other players... each new skill isn't enough" [1]. In a Time [13] article, Denise Dituri, a mother of three, who had no interest in fantasy games, became an 18 hour a day

player in Everquest. But instead of ruining her family, the game has seemingly brought them closer together. Denise and her husband Gary play Everquest with their three children, viewing the game as an activity of the mind, and as an alternative to television. Gary confesses that he has learned more about his son than ever before while playing Everquest. Even the topic of dinner conversation in the Dituri household is over what happened while they were in Everquest.

Young [17] provided research that certain users become addicted to specific applications used on the Internet. Griffiths [4] concluded the same, with results showing that addicts are usually addicted to online chat or fantasy role-playing games (MUDS). Griffiths also emphasized that these applications allowed users an anonymity allowing them to create their own social identities, raising the users' self-esteem. It is this anonymity that gives those with low self confidence and sub-par social skills the desire to create a virtual life for themselves on the Internet. In these cases, the Internet becomes a substitute for real life social interaction, giving the user an escape from reality [18]. In the early 90's the Internet addict was stereotyped as a male computer hobbyist, but recent research proves that anyone can become addicted, as it is a combination of personality type and Internet application that causes overuse leading into addiction.

MATERIALS AND METHODS

In this study, a comparison will be made between online MMORPG game users and offline video game users, to find elements that differentiate the two types of users and factors that contribute to overuse. It is proposed that factors which cause Internet overuse are similar to those that cause MMORPG overuse.

The evaluations took place online in the form of two surveys which served to compare the two types of users. The surveys are based on a survey developed in 1999 by Pratarelli et al. in their paper "The bits and bytes of computer/Internet addiction: a factor analytic approach" [9]. Pratarelli's survey focused on variables indicative of both computer and Internet use and was devised to gather data on the behavioral patterns of heavy Internet users. This survey has been modified to explore the individuals who are primarily MMORPG or video game players (respectively, online and offline game players). To facilitate the comparison study, the same survey was used for the testing of both user groups, with the exception of the terms "MMORPG" and "video games". These two terms were replaced in the context of its respective test; this preserved the questions yet changed the context. The survey questions were collected anonymously through an online survey which was advertised on various gaming forums hosted on well known gaming sites eqvault.ign.com, www.everlore.com and www.fohguild.org. After 10 days, the surveys were taken offline. No rewards were offered to those who volunteered to participate. Questions are generalized so that any sample user from the general population who has played MMORPG's or video games can answer. If a user were primarily a MMORPG player, they were asked to complete the MMORPG survey, and similarly for video game users.

Individual survey items gathered data on demographic information, game usage patterns, social behaviors of users, and the user's game purchasing habits. Demographic information collected was gender, educational level, professional level, hours per week spent playing games, and time of day spent playing. All remaining questions were Likert scaled responses; users were asked to rank their agreement or disagreement to each question on a scale from 1 to 5. Game usage questions focused on how much time users were spending on games, how long a typical session would last, if usage time affected their daily schedules, and measured for indications of spending too much time using games. Social behavior questions collected data on dependence, companionship, self-image, and attitude of the user while gaming. Lastly, users answered questions about their game purchasing habits.

RESULTS

The MMORPG survey demographics had a total of 91 responses. 88% of those were male, 44% had a high school degree and 29% had a bachelor's degree. 37% were students while 53% worked as full-time employees. When asked how many hours a week they spend on MMORPG's, 13% spent between 7-10 hours, 25% spent 11-20 hours, 34% spent 21-40 hours

and 11% spent 40+ hours playing a week. 82% played during the hours of 6pm-11pm.

Demographic data for video game users was quite similar to MMORPG users, as expected. 48 responses were reported, and of those, 71% were male. 25% had a high school degree and 54% had a bachelor's degree. 29% were students and 71% were full-time employees. In contrast to the hours spent playing per week, video game users spent significantly less time playing their games per week. 38% played for 1-2 hours a week, 35% spent 3-6 hours and 6% spent 7-10 hours a week. 87% played during the hours of 6pm-11pm, which was similar to the MMORPG players.

Likert scaled questions on game usage patterns, social behaviors of users, and game purchasing habits were analyzed with an unpaired t-test for significance between the two groups test results. According to the data on game usage patterns, 6 of the questions on showed a high significance (P=0.0001), 2 showed some significance and 2 did not have any significance. MMOPRG players had tendencies of playing for 8 continuous hours, losing sleep because of playing, and have been told they spend too much time playing. All questions which suggested heavy overuse were dominated by the MMOPRG users. Social behaviors of users varied for the two groups, as significance was found in 50% of the questions in this category. MMORPG users would rather spend time in the game than with friends, have more fun with in-game friends than people they know, found it easier to converse with people while in-game, did not find social relationships as important, and felt happier when in the game than anywhere else. Offline game users had sought out video games to alleviate depression at times, while MMORPG users didn't. However, neither group used games as a diversion from loneliness or to gain self-confidence. Spending on games between both groups showed no significance, as neither group had any monetary issues associated with gaming.

DISCUSSION

The findings confirm the background that has been presented and highlights the differences between the two groups. It is clear that MMORPG users have a tendency to spend many more hours devoted to their game and find the social aspects of the in-game world more pleasant and satisfying than what occurs in the real world. However, MMORPG users don't seek self-confidence in-game, would find fun elsewhere if MMORPG's didn't exist, and would not feel irritated if they didn't have the chance to play for one day. This would suggest that as much as MMORPG users enjoy the time they spend in-game, even more so than real life activities with friends, they are not addicted. I would propose that MMOPRG users have a different perspective on social life, which could be labeled as anti-social or introverted by most, and as such choose to spend their social time and energy in-game rather than socializing in the real world. It is because of the social aspects inherent in MMORPG's that draws in the "hard-core" players who show patterns of addiction. For most users it would seem that MMORPG's are an alternative to other forms of social entertainment. If MMORPG's weren't available or didn't exist, these same users wouldn't seek friends or social situations such as parties, bars or clubs, but perhaps other forms of socializing online in the form of emails, chat rooms or instant messenger. Since it is apparent that most users are not addicted, but rather choosing to spend their time on MMORPG's, determining how they spend their time in-game could explain their attraction to the games. For future study, these social aspects and in-game activities could be explored in-depth. In conclusion, it is the social aspects that exist in-game that draw users into MMORPG's. Much like users who are addicted to the Internet, they seek social experiences which are not available elsewhere in their lives. Even with high usage times, MMORPG users cannot be categorized as addicted, because they do not exhibit the behaviors of addicts.

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Abstracts

Presenter: Robert S. Astur, Ph.D.

Using Virtual Reality to Investigate Functioning of the Hippocampus in Schizophrenia

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Research status: Completed

Everyday life requires us to locate places in our environment and navigate them efficiently. One brain structure that is essential for normal navigation is the hippocampus. Coincidently, the hippocampus is a metabolically fragile structure, and is often damaged as the result of a variety of psychiatric conditions, including Alzheimer's disease, epilepsy, post-traumatic stress disorder, and schizophrenia. For example, it has been shown that individuals with schizophrenia have smaller hippocampi than age-matched controls, and neuronal pathology exist within their hippocampi. By using VR during functional brain imaging, we can examine the extent to which individuals with schizophrenia utilize their hippocampus while they are navigating through virtual environments.

Twelve individuals with schizophrenia and ten age-matched controls were tested on a virtual Morris water task in a functional magnetic resonance imaging (fMRI) paradigm. Participants were virtually placed in a round pool and had to locate a hidden goal area. The virtual environment was created using 3D Game Studio, and was shown via an LCD projector on a screen that the patients viewed using 45-degree mirror glasses while lying supine in the MRI scanner. The participants navigated through the pool to find the hidden platform using a MRI-compatible joystick. Sixteen slices were obtained in the coronal oblique plane perpendicular to the long axis of the hippocampus using a GE Signa 1.5T MRI system.

The results indicate that the individuals with schizophrenia displayed impairments in navigating to the goal area compared to the age-matched control participants. By examining the brain structures used during virtual navigation, we note that the control participants have significant hippocampus involvement during virtual navigation, whereas the individuals with schizophrenia do not. We also note that the individuals with schizophrenia have different patterns of activation in the cingulate cortex, insular cortex, and left middle frontal gyrus relative to control participants.

Hence, it appears that individuals with schizophrenia do not use their hippocampus during navigation to the same extent as controls. It is not immediately clear whether this difference is due to the patients being unable to use their hippocampus normally (i.e. They have a dysfunctional hippocampus, and it can't work normally) or whether other factors such as low motivation may have caused the patient group to use a non-spatial strategy (i.e. They have a normal hippocampus, but were using a strategy that would not activate it). Additional analyses and experiments are underway to disambiguate these two hypotheses.

Our research is unique in that we use VR to investigate the brain processes involved in navigation in an fMRI paradigm that requires immobility of the participant's head. This task is ideal because it is a virtual analogue of a common rodent task called the Morris water task. Given that the hippocampus is damaged in a variety of psychiatric and neurological illnesses, it allows us to use a single task across-species to monitor hippocampus functioning as well as the efficacy of pharmaceutical and behavioral therapies aimed at improving memory function.

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Presenter: Rosa Banos, Ph.D.[1]

Virtual Reality as a Psychological Laboratory: Its Utility for Assessing Attentional Biases in Anxiety Disorders.

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Virtual Reality (VR) is a useful tool in the field of psychology, but its applications have mainly centered on its utility as a therapeutic tool. However, VR could also be very helpful for basic research. It allows researchers to present stimuli and to register responses in a controlled manner and in an environment that "simulates the reality" (Baños et al., 1999; Botella, et al., 1998). The experimental paradigms used to study cognitive processes in mental disorders have had to sacrifice ecological validity in favor of internal validity. Examples of these paradigms in the study of attentional processes are the "dote probe task" and the "emotional Stroop task". Both tasks try to demonstrate that persons with anxiety disorders preferentially direct their attention towards threatening stimuli (e.g., Williams, Watts, MacLeod, & Mathews, 1997).

Words or photographs with different emotional weight are presented to the participants, and the performance of people with anxiety disorders and individuals without these problems are compared. However, both words and photographs are static stimuli, presented in two dimensions, and lacking any context. Therefore, if the aim of the clinician is to understand how a person with a specific phobia directs their attention in a feared situation, a more reliable result would come from assessing his or her attentional performance in that situation, in contrast to the presentation of words or drawings. Obviously, there would be notable difficulties regarding internal validity if the situations took place in real life, since a total control would not be possible, but this problem could be minimized in a VR laboratory where the stimuli could be presented in a controlled manner. Moreover, the presentation of the stimuli could also be done outside the conscious awareness of the individual by jointly using subliminal perception strategies. In this sense, VR allows us to study an issue that is difficult to grasp in the real world.

In order to study the feasibility of VR as a "realistic" laboratory where attentional processes in specific phobia (spiders and cockroaches) can be studied, our team has developed an environment where a house is simulated and a version of the dote-probe task has been introduced. The person has to explore this environment and find several keys that appear during a brief period of time. When they are detected, the individual has to press the bottom of the mouse so the computer can register whether the response is correct and complete within the time required to make the decision. The computer controls the presentation of the stimuli and its exact location. The keys appear in the same location just after a threatening stimulus (spider or cockroach) or a neutral (watch) is presented.

First, the keys are presented after a series of randomized subliminal presentations of the spider/cockroach and the watch. After a break, during which the person stays immersed in the virtual world, he or she is asked to find padlocks, which appear in the same way described for the keys (but the stimuli are presented in a supraliminal way). The differences between groups (phobics and non-phobics) and within the groups will be analyzed. In the present work, the VR scenarios and the experimental tasks are described.

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Presenter: Steve Baumann, Ph.D.

Smoking Cues in a Virtual World
Provoke Craving in Cigarette Smokers as Demonstrated by Neurobehavioral and fMRI Data

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Fifteen cigarette smokers participated in a study of the ability of smoking cues within a virtual world to provoke craving-to-smoke. Subjects were asked to abstain from smoking for at least 12 hours prior to testing, confirmed by CO analysis of expired breath, and then completed a questionnaire concerning their smoking history.

Subjects were seated in front of a 21-inch color monitor and given a short practice session. Then they were placed in a VR simulation that did not contain any intentional smoking stimuli and were instructed to explore a sequence of environments with occasional directions from the experimenter. At various points during the simulation, the experimenter brought up a rating scale, and the subjects were asked to rate their urge to smoke on a scale of 0-100.

In the second run various smoking stimuli were placed in the simulation at strategic locations that the subject would likely encounter. These stimuli included opened packs of cigarettes, lighters, ashtrays, advertisements, cigarette vending machines, cigarette cartons for sale, characters smoking and a bar scene. Once again, subjects were asked to rate their urge to smoke at various points during the simulation.

Each run lasted approximately 10-15 minutes. The rating data was automatically saved to an Excel spreadsheet. An overall change-in-craving score between runs was computed for each subject. Despite a nearly identical mean rating at the beginning of each run, the results showed a 15.7 mean increase in urge to smoke between runs. Thus, the embedded smoking stimuli provoked a highly significant increase in craving between the two runs ($p<0.00014$ one-tailed paired t-test).

Six subjects with the highest differential rating between runs were recruited to participate in an fMRI pilot study several weeks later using a Siemens 3T Allegra scanner. Four subjects were smoking-deprived for at least 12 hours prior to the scan, and two were allowed to smoke as usual. Each subject participated in two runs, one without smoking stimuli and one with smoking stimuli. Echo planar imaging data from the two runs were combined and differences between and within the runs were studied.

Individual analyses showed activation of normal sensory (visual, sensorimotor) and motor areas, indicating that the imaging technique could detect normal activation in these subjects. Additionally, the individual analyses revealed clear and highly significant activation of multiple areas previously reported involved in drug craving and cigarette smoking. In the deprived smokers there was highly significant activation in the amygdala (2 subjects), hippocampus (1), prefrontal cortex (3), parietal association areas (2), and inferior rectus gyrus (2). In addition there was highly significant deactivation in widespread areas, especially of the frontal lobes bilaterally. In comparison there were no areas of significant cortical deactivation in the two control smokers, who were allowed to smoke right up until the fMRI study began.

This study demonstrates that both self-report and physiological data indicate that appropriate VR simulations can be used to manipulate craving in addicted smokers.

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Presenter: Patrick S. Bordnick, MSW, MPH, Ph.D.

Development and Testing of a Virtual Reality Cue Reactivity Environment for Nicotine Dependent Cigarette Smokers

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Research Status: Preliminary completed clinical trial

Background:
Drug related stimuli/cues (cigarettes, other people smoking) have the ability to elicit both physiological and behavioral reactions e.g., craving in nicotine dependent cigarette smokers. Traditional cue exposure methods involve bringing smokers into austere laboratory environments and using videos, still pictures, and paraphernalia to elicit craving and physiological reactivity. While these methods have led to craving and physiological reactivity, their generalizability outside of the lab and utility in clinical setting remains in question. Thus, a virtual reality cue exposure (VRCE) environment was developed to test the reactivity of nicotine dependent cigarette smokers to virtual cues. VRCE combines the elements of VR with specific inanimate smoking cues, environments, social interactions, and other related stimuli in a virtual environment appropriate for laboratory and clinical settings. VRCE combines both computer generated and video images depicting smoking cues (e.g. cigarette packages, ash trays, burning cigarettes) and smoking social interactions (e.g. being offered a cigarette in a social context). VRCE expands traditional cue exposure methods by allowing participants to experience "real world" smoking situations in a controlled VR setting. After development and beta testing, the VRCE environment was tested in a clinical trial with nicotine dependent cigarette smokers.

Methods:
20 male and female nicotine dependent smokers participated in the VRCE clinical trial. After a 20-minute deprivation period, cigarette smokers were exposed to both VR neutral stimuli and VR smoking related stimuli using a VFX-3D HMD (Interactive Imaging, Rochester, NY) connected to a 2Ghz P-IV PC. The presentation order of inanimate and animate stimuli was counterbalanced to control for the total time in VR. In addition, a Coulbourn Lab Linc V system (Coulbourn, Inc. City, State) was used to measure heart rate, Skin Conductance Level, and respiration during VRCE sessions. We hypothesized that smokers who are exposed to VR smoking related cues/stimuli will have greater physiological reactivity (heart rate, respiration, and skin conductance) and will report increases in subjective urges and craving compared to VR neutral cues/stimuli.

Results:
Twenty cigarette smokers participated in the clinical trial. Participants smoked at least 21 cigarettes per day, experienced craving, and were in good physical health. Comparisons were made on both craving and physiological measures between the smoking and neutral cue rooms. Data will be presented for all clinical variables including subjective craving reports and physiological data.

Conclusions:
The demonstration of reactivity in smokers to VR smoking cues provides a foundation to develop additional VR environments and test VRCE in clinical treatment studies for efficacy.

Novelty/discussion:
This is the first VR program in addictions to incorporate neutral, inanimate, and animate environments that utilize realistic video images and allow participants to interact with people instead of computer-animated avatars, arguably producing more realistic interactions. VRCE offers a new medium for both clinicians and researchers who work with addictions to bring cue exposure into the treatment setting. The VRCE program will lead to significant advances in understanding craving and other clinical phenomenon that may lead to relapse in cigarette smokers.

This research was supported by NIDA Grant #1-R41-DA016085-01. Authors also thank the staff at Coulbourn instruments for their support in collecting physiological data.

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Presenter: Cristina Botella, Ph.D.[1]

Telepsychology and Self-Help: The treatment of phobias using the Internet

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Phobias are one of the most common psychiatric disorders. It is estimated that about 11% of the population suffers from a specific phobia (Magee, Eaton, Wittchen, McGonagle & Kessler, 1996). Currently, in vivo exposure is a very effective procedure available for the treatment of phobias (Nathan & Gorman, 1998, 2002). However, it is estimated that only 15% of phobics seek treatment (Boyd et al., 1990). Moreover, many persons who are referred to receive treatment do not receive it due to a lack of adequately trained professionals. Because of this, we think that it is important to develop strategies that increase the availability, attractiveness, and acceptance of treatment for phobias. Making the treatment easily available can be a good way to achieve these objectives.

Some studies have already been done that explore the possibility of using the Internet to provide help. The Internet has been used to reduce risk factors for eating disorders (Winzelberg, Eppstein, Eldredge & Winfley, 2000; Celio, Winzelberg, Wilfley, Eppstein, Springer, Dev & Taylor, 2000), to apply treatment for recurrent headaches (Ström, Petterson & Anderson, 2000), and to apply a program for posttraumatic stress disorder (Lange et al., 2000). However, there is only one study carried out by our own group in which the whole treatment is totally available on the Internet, including the feared scenarios to apply exposure, where the participation of the therapist is not required. It is therefore a completely self-applied program (Botella, et al, 2000; Botella, Baños, Guillén, Perpiña, García-Palacios, Alcañiz, & Pons, 2001). This study is about public speaking fears, and the feared scenarios consist of real videos with threatening audiences for people who have this problem.

In the present study, a telepsychology system that uses Internet for the treatment of animal phobias is presented. The program allows a step-by-step self-application of the treatment, controlled by the system itself without any contact between patient and therapist. The system is composed of: a) an assessment protocol that gives the patient a diagnosis of his or her problem, including the interference it is causing him or her, its severity, and the degree of fear and avoidance it is producing; b) a structured treatment protocol, organized in separate blocks reflecting the patient's progress. In this way it is possible to ensure that the patient does not skip any steps in the treatment (a common problem with traditional self-help manuals), gaining more control over the process; and c) an outcome protocol that assesses treatment effectiveness at every intermediate step as well as at the end of treatment.

The results obtained in a case series analysis with 15 participants are presented. These indicate the benefit of continuing to work to develop effective treatments, which are increasingly available to the patient. This means a notable advance in therapeutic cost-benefit. The combination of new technologies together with self-help material seems to be a promising alternative that can help to solve some existing problems in the field of mental health.

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Presenter: Stephane Bouchard, Ph.D.

A Hint on the Relationship Between Fear and Presence

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Université du Québec en Outaouais

Context:
In previous studies, we have observed that anxiety and presence are correlated. The purpose of this study is to explore this relationship in order to understand the direction of the causal relationship between presence and emotions felt in VR. Our hypothesis was that increases in anxiety would lead to a stronger sense of presence.

Method:
The sample consisted of 26 women aged between 27 and 68 years old ($M = 45{,}23$; $SD = 11{,}35$) and 5 men aged between 32 and 56 years old ($M = 43.60$; $SD = 10{,}02$). The subjects were first SCID-diagnosed to confirm the presence of snake phobia and randomly assigned to one of two conditions. The design was a randomized repeated measures ANOVA with three subsequent immersions (a control immersion [CTRL environment] and two experimental immersions) and two conditions: (a) a VR immersion in an environment «filled» with hidden snakes, which should induce anxiety (ANX environment), and (b) a VR immersion in <u>the same</u> environment as in (a) but without any hidden snakes, which should not induce any anxiety (NOANX environment). In the NOANX environment, participants were immersed in a virtual environment depicting a desert with pyramids and temples. They were asked to visit it for five minutes and were told that the environment was safe and contained no snakes. In the ANX environment, participants were immersed in the <u>exact same environment</u> and had to perform the same task, but they <u>were led to believe</u> that the

environment was plagued with hidden dangerous snakes. To sum up, participants in the first condition were immersed in the CTRL environment, then in the ANX environment followed by the NOANX environment. For the second condition, the sequence was immersion in the CTRL environment, in the NOANX environment, and in the ANX environment. The immersions in the ANX and NOANX environments were separated by a distraction task consisting of reading of a relaxation text and answering questions about it. Each VR immersion was followed by measures of presence and anxiety. At the end of the study, the participants were trained to use a self-help manual for their phobia in compensation for their participation.

Results and conclusion:
A manipulation check confirmed that participants were significantly more anxious in the ANX environment than in the other environments. Results of the repeated measures ANOVAs showed that presence was higher in the anxiety provoking environment than in the control or the non-anxious environment, as confirmed by the significant Condition by Time interactions and the interaction contrasts (all $p < .01$). The results are discussed in the light of the measurement of presence and the relationship between emotions and presence. It appears that an emotion such as anxiety is increasing significantly the sense of presence in a virtual environment. The opposite relationship still has to be tested. However, it suggests that in addition to hardware and software variables, people's internal states are providing additional cues to create the sense of presence.

Presenter: Alex H. Bullinger, M.D., MBA

Development and Evaluation of a Modular Psychophysiological Test Battery for Use with Virtual Environments/Augmented Reality Applications

Mara Kottlow; Robert Stoermer, MD;
Ralph Mager, MD; Franz Mueller-Spahn, MD; Angelos Amditis, PhD; Alex H. Bullinger, MD

Research status: Completed

Background:
The question, what Virtual Environments of all sorts do to their respective users, for years was reduced to investigating the various side- and after-effects that these integrated systems may cause. While these questions still are not obsolete, they are of far less importance, due to highly sophisticated technological solutions to the main problems causing these side- and after-effects, like system delays, insufficient and ergonomically poor I/O – devices, etc. Therefore the research focus under the heading "What do VE-Systems do to their users" shifted rather slowly towards performance, usability, acceptance and awareness issues. At the beginning of such studies it became obvious rather quickly, that when it came down to rating, measuring and objectifying, usually paper and pencil – based tests and/or questionnaires was all there was and by and large still is.

In contrast, what was needed were tools for obtaining objective parameters from VE users, that could

- not be influenced voluntarily by the user
- be regarded as intra-individually stable as well as inter-individually comparable
- serve as "mosaic stones" for more complex psychological constructs like attention, vigilance, stress, etc.
- serve as performance indicators with respect to the virtual task

The few solutions that were on the market covered only parts of these requirements and most of them were not applicable within VEs and/or had no real-time capabilities. In addition to these few off the shelf systems there were also a few applications that respective research labs or groups custom-tailored to their applications.

Having in mind the requirements as well as the shortcomings of the existing solutions, in the course of the pan-European research project "Virtual and Interactive Environments for Workplaces of the Future (VIEW)" a modular platform as well as application independent test battery for VEs of all sorts was developed.

Method/Tools:
Based on the criteria and methodologies obtained from pilot studies, questionnaires and guided interviews with developers and users of VEs of all sorts (reaching from industrial design over manufacturing to health related applications), a concise test battery was developed,

consisting of:

- a paper and pencil – based module, formed by a rapid mixture of standardised questionnaires and self-rating scales
- a real-time psychophysiological module
- a real-time neurophysiological module

This test battery was designed to be able to estimate mental workload, cognitive performance, stress, attention, vigilance, as well as related constructs. The test battery is modular, so that different parts of it can be used for different types of VE-applications, depending upon complexity, hours of continuous use, type of user and environment, cost, etc.

For evaluation purposes the test battery was used during a variety of VE-based pilot applications; the results will be summed up in the course of the presentation.

This research is co-funded by the European Commission, grant number: IST-2000-26089, VIEW http://www.view.iao.fhg.de

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Presenter: Mignon Coetzee, Ph.D.

A Low cost VR group support system for people living with HIV

Sabeeha Hamza, Mignon Coetzee, Edwin Blake, and David Nunez
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Research Status: In progress

Abstract:
Social support has been shown to improve the quality of life of HIV/AIDS patients, and HIV/AIDS counseling and support groups have traditionally been used as a means of providing social support to patients. Given the high HIV infection rate, South Africa faces a shortage of counseling resources. This study investigated the possibility of using virtual reality technology to provide emotional and informational support to HIV/AIDS patients. Our system was partly motivated by other systems that have been successfully used to provide support for breast cancer patients (eg. Breast Cancer Lighthouse and Easing Cancer Park). If a low cost VR support system were effective, it could greatly increase the number of HIV/AIDS patients receiving support.

We developed a low cost, deployable desktop PC based system using custom software. The system implements a VR walkthrough experience of a tranquil campfire in a forest. The scene contains four interactive avatars that relate narratives compiled from HIV/AIDS patients. These narratives cover the aspects of receiving an HIV+ diagnosis, intervention, and coping with living with HIV+ status. To evaluate the system, seven computer semi-literate HIV+ volunteers from townships around Cape Town used the system under the supervision of a clinical psychologist. The participants were interviewed about their experiences with their system, and the data was analyzed qualitatively.

In terms of emotional impact, the participants found their experience with the system mostly encouraging, particularly the narratives relating to adjustment and coping. They found it encouraging hearing from other HIV+ individuals rather than from other sources. The participants liked the availability of the computer system, and found it preferable to TV or pamphlets as a source of information, due to its interactivity and the control it affords over content delivery. The system was also preferred due to the anonymity it provides to those not willing to reveal their HIV status. The system highlighted the potential benefits of joining a support group, and motivated some participants to make more use of support groups. In general, participants found using the system an uplifting experience, reinforcing their strength in coping with HIV. As compared to other forms of therapeutic intervention, participants reported that they received a similar cathartic experience. The system was considered ideal for patients who, because of their fear of disclosing their HIV status, are not receiving support. The participants generally preferred real support groups rather than the VR system, but felt that the system could aug-

ment counseling tools, and that it could be of benefit in places where counseling resources were not available, or in cases where joining a support group was difficult.

Our study establishes the usefulness of low-cost VR systems in the counseling of HIV/AIDS patients in developing communities. Such systems cannot replace counseling, but can play a role in steering people towards seeking counseling, as well as providing limited support in cases where counseling resources are not available. Our findings, although preliminary, have encouraged the further development of our system by extending the degree of informational and emotional support it provides.

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Presenter: Sophie Côté, Ph.D. Candidate

The Use of a Pictorial Stroop Task and Psychophysiological Measures in Understanding Cognitive Mechanisms Underlying Virtual Reality Exposure Effectiveness

Sophie Côté, B.A., Stéphane Bouchard, Ph.D.
Cyberpsychology Lab of the University of Quebec in Outaouais (Hull, Quebec, Canada)

Research status: Still in progress

Background:
In virtual reality (VR) research with exposure treatment for phobias, many efficacy studies have been realized. Most of them were successful in showing that VR exposure is at least as effective as in vivo exposure. However, few studies have been done on treatment mechanisms. In what dimensions is VR exposure effective? Is this technique suggestive enough to elicit fear when the participant knows the stimuli are not real? Is exposure affecting cognitive processes in the brain? Many subjective measures, such as questionnaires, are available, but they remain very subjective. This is where objective outcome measures become interesting.

Method/Tools:
In this study, 10 arachnophobics went through a VR treatment program. They received 7 sessions of CBT (60 mins each). During the first session, participants were SCID-diagnosed with a specific phobia (spiders), according to the DSM-IV. Subjects suffering from major comorbid disorders, epilepsy, major heart or vestibular problems were excluded from the study. During the second session, participants received information about phobias and CBT, while the last five sessions were devoted to gradual exposure therapy using virtual reality. Virtual worlds were created using a 3D computer game (Max Payne), modified to offer gradual hierarchies of fearful stimuli (spiders). The virtual reality exposure was conducted with a Pentium IV computer, an I-Glass head mounted display and an Intertrax2 motion tracker.

Participants filled out questionnaires assessing spider phobia, anxiety, perceived self-efficacy and immersion propensity both pre- and post-treatment. They also went through a Pictorial Stroop task, in which they had to identify the

color of a filter placed over pictures with various emotional contents (spiders/negative, cows/ neutral and rabbits/positive). Finally, they went through a behavioral avoidance test, in which they had to press a button to make a platform move forward. On this platform was a tarantula in a transparent plastic box, lid open. During this task, participants' heart and respiratory rate were recorded using CardioPro. After each exposure session, participants filled out questionnaires assessing cybersickness and sense of presence in the virtual environments.

Conclusions:
As the work is still in progress, final data were not available at the time this abstract was written. The use of psychophysiological measures to better understand cognitive mechanisms underlying the effectiveness of VR exposure in the treatment of phobias is relatively rare, even in studies with in vivo exposure. Many debates still persist in this field and results are encouraging, but sometimes contradictive. Hopefully, this study can clarify many issues and stimulate the inclusion of more objective and reliable measures, in addition to subjective measures, in the field of virtual reality.

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Presenter: Eamon P. Doherty, Ph.D.

Low Cost Facial/Mental Controlled Tele-robotic/Tele-Medicine System for Quadriplegic Persons

Eamon P. Doherty, Ph.D., Fairleigh Dickinson University; Gary Stephenson, BA(Hons), AMBCS, Self Employed Consultant to British N.H.S; Joel Fernandes; Dency Baskaradhas M.S.; Pavani Aitharaju, Fairleigh Dickinson University Students

Research Status:
The facial/mental controlled telerobotic system research was completed and approved by the university IRB. Our future research includes adding an extra window so a doctor can observe the telerobotic operator, thus making the vocational/rehab tool a telemedicine diagnostic tool.

Background/Problem:
A quadriplegic man wants to be able to work at a local pharmaceutical company as a technician to mix chemicals, but is not allowed to leave his bed due to unhealed wounds. A telerobotic system is needed so that he can work remotely. The system needs to be operated by impulses at the forehead because the man has no use of limbs. The quadriplegic man would also not mind if an additional window was added so his doctor could observe him and show he is in good physical and mental health and can operate machinery. This tele-display may allow the doctor to concentrate on his other patients who live in remote places and need his care. Telehealth is realized as a growing need in the 21st century. American Richard Grainger, director general of the UK NHS National Programme for IT (NPfIT), is currently spearheading a £2.3bn project (Delivering 21st Century IT Support for the NHS) to overhaul National Health Service IT, and Telemedicine or Telehealth[1] will be expected to supply many patient-centric benefits in this plan.

Methods/Tools:
A visual C++ program was created to operate with a robotic arm, interface board, and a webcam. This system was also connected to the Internet. A second laptop was also connected to the Internet and Microsoft Netmeeting was installed. A person was then asked to use a Don Johnston EMG controller or Cyberlink mental interface to select scanned buttons representing robotic arm functions at the other remote robotic arm site and control it real time through the Internet. The person controlling the arm was watching the movements on a video window on the desktop.

Results:
The person was able to operate the robotic arm in a real time environment and do tasks. The delay between the robotic arm movements and video was negligible because the resolution of

the video camera was kept low but at a resolution that was clear enough to allow the user to do a task. The user was also happy to be able to control something remotely.

Novelty/Discussion:
The test subject asked his therapist and they know of no other telerobotic systems that he can operate. Other telerobotic systems were of a military nature [2] or for the chemical industry [3]. There was one experimental telerobotic arm system at Duke University, but was still being used in experiments involving monkeys [4]. A low cost telemedicine telerobotic system is a novel approach and allows vocational rehabilitation and tele-medicine diagnostic application potentials for doctors who cannot readily visit patients in remote places.

Conclusion:
It may be possible to assess attitude, motor skills, and general health by watching the user perform a task. It seems that the system may have potential as a telemedicine diagnostic tool in addition to a rehabilitative vocational tool.

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Presenter: Stephanie Dumoulin

The Sense of Presence in Videoconferencing and Emotional Engagement

Stephanie Dumoulin, B.Sc., Stephane Bouchard, Ph.D., & Melanie Michaud, B.Sc.
Cyberpsychology Lab of the University of Quebec in Outaouais (Hull, Quebec, Canada)

Research status: Almost complete

Background:
Videoconferencing is a communication medium that allows therapists to conduct psychotherapy sessions with clients that are far away (e.g. rural areas). Ongoing research in our lab suggests that the development of a therapeutic alliance is possible but related to the illusion of presence. However, there is no empirical data to document the relationship between presence and the emotional engagement and how it takes place.

The objective of this study is to determine if the extent to which an individual is engaged in an emotionally charged discussion affects presence.

Method/Tools:
The sample consists of 40 participants between 20 and 56 years of age assigned randomly to two conditions: (a) High Emotion First (High-EF; describing a highly emotional event first, followed by the description of a less emotionally involving event), or (b) Low Emotion First (Low-EF; same as the other condition but in the opposite order). For the study, two Vision 5000 systems from Tandberg are used, connected by TCP/IP at a rate of 384 kbits/s.

The procedure was to first identify and rank five positive events that the individual has experienced and then select the most and the least emotionally involving ones. The Immersive Tendency Questionnaire and the Attitude Toward Telecommunications Questionnaire were then completed, followed by a 15-minute discussion in videoconference about the first emotionally involving event. The Presence Questionnaire in Videoconference was then completed, followed by a distraction task. Finally, participants discussed the second emotionally involving event for 15 minutes in videoconference and completed the presence questionnaire again.

Results and Conclusions:
The results show that the sense of presence isn't highly affected by the emotional content of the discussion. However, the individuals who

felt more comfortable communicating via videoconferencing experienced a stronger sense of presence. Increasing the sample size would allow more power to find a significant Time x Condition interaction between the High-EF and the Low-EF conditions.

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Presenter: Uri Feintuch, Ph.D.

Development of a "Low End" Multimodal Feedback Program for Motor, Cognitive and Sensory Rehabilitation

Uri Feintuch Ph.D.[1], Debbie Rand M.Sc.[1], Rachel Kizony M.Sc[2], and Patrice L. (Tamar) Weiss Ph.D.[1]

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Research Status:
Software design and description; Planned study

Background:
Feedback from tactile and kinesthetic receptors contributes to the haptic sense, enabling us to manipulate objects with precision and smoothness. Cumulative evidence, from both neurosciences and clinical research indicates the important role that haptic feedback may play in rehabilitation intervention. Neurophysiological studies suggest that specific haptic stimuli may facilitate plasticity processes required to recover damaged sensory and motor maps in the brain [1]. Moreover, haptic stimuli have been shown to be involved in Cross Modal Transfer, where knowledge acquired in one modality improves performance when employing another modality [2]. The benefits of using haptic feedback as part of therapy for patients with stroke have also been demonstrated [3]. The inclusion of haptic information within virtual environments may enhance performance, relevance, reality, meaning and presence.

Problem:
The roles of haptic feedback in virtual environments and its potential benefits for cybertherapy have not been systematically characterized. Thus, it is not clear which types of impairments (motor, cognitive, sensory) will be most helped by the addition of haptic feedback. To a large extent, this void is due to the high cost and encumbrance of many of the currently available haptic devices. The objective of this study was to develop a "low-end" multimodal (visual, auditory, haptic) feedback program that would enable clinicians to easily design a diverse assortment of virtual environments for the delivery of tasks suited for the rehabilitation of motor, cognitive or sensory deficits.

Method/Tools:
We have created software that runs on a standard PC desktop and uses an off-the-shelf haptic joystick interface (Microsoft's Sidewinder Force Feedback 2). This user-friendly program enables a therapist or researcher to quickly design audio-visual-haptic environments. The program has two components, an Editor and a Simulator. The therapist uses the Editor to place objects of different sizes and shapes on the screen. These objects are assigned various attributes such as color, sound, movement, and type and intensity of haptic feedback. Juxtaposition of the virtual objects and association of their attributes enables the creation of simple as well as complex environments (e.g., dynamic mazes). The Simulator is then employed for running experimental trials or for conducting intervention. Although simple to operate, many sophisticated game-like tasks may be designed and used for a gamut of research/treatment goals that test and train participant abilities including:

- cognitive deficits (e.g., executive functioning, spatial orientation, memory)
- motor deficits (e.g., motor planning, motor control)
- sensory deficits (e.g., orientation and navigation skills for people who are visually impaired, proprioceptive deficits for patients following stroke, reeducation for peripheral nerve injuries)
- functional skills (e.g., simulator training to learn to operate a powered wheelchair)

The software will be first tested with a group of healthy subjects and with patients who have had a stroke and whose deficit is primarily sensory. Their ability to perform mazes of varying difficulty under visual-auditory, visual-haptic,

and visual-auditory-haptic conditions will be compared to determine the contribution of haptic feedback to task performance.

Novelty:
This software makes the use of haptic feedback widely accessible to the cybertherapy community. It offers a wide array of therapeutic tools which are easy to design and execute. In addition to its immediate clinical applications, we anticipate that this tool will allow for future studies of cross modal tasks, eventually leading to the development of additional, haptic-based therapeutic interventions.

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Presenter: Carlo Galimberti, Ph.D.

Artifact Based Trust in On-line Interactions 2: Relevance to telemedicine, on-line psychologic counseling and therapy.

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Research Status: Completed.

Background:
The work aims at the definition of a model about how trust is built in on-line interactions to be applied in different situations: on-line therapy, on-line psychological counseling and trust based on-line interaction.

Method:
One of the main problems of on-line interactions consists of winning the users' resistance in order to gain trust. As trust is not only based on previous experiences but also on feelings and impressions emerging during the interaction, the study aims at finding out which elements make a website trust-worthy.

In order to obtain basic information about web interaction processes, the project has been divided into two different phases:

- first phase: on-line interactions in laboratory context
- second phase: on-line interactions 'observed' in real context adopting an ethno-methodological approach

We applied both traditional and new usability methods suitable for the test performed:

- voice recording of users' comments during the interaction (thinking aloud)
- interviews (post cognitive walkthrough)
- questionnaire
- personal journal
- simulation game (e-commerce website project)
- on-line questionnaire

Novelty:
On the basis of the collected data, a model was prepared to represent web-based trust building and maintenance processes. In this model, interface elements are the starting point to perceive information on the web-site structure, on the catalogue structure and to get information on items included. Information collected allows the user to create a mental model of the whole interaction process, instead of just the web site. This model is based upon "structure" and "contents".

The mental model is interpreted and applied in order to find out information on the products, on the 'other' speaking through the web site, on any other interlocutor and on the interaction itself. This information is then evaluated, accord-

ing to different criteria:

- Interest
- Satisfaction about the interaction
- Perceived competence
- Perceived transparency

The "Interest" criterion is applied in order to decide to carry on the interaction or not: it is based on motivation, which consists in the cost. "Satisfaction about the interaction" underlines the importance of usability and accessibility of the site. "Perceived competence" is an element pertaining to the users' mental model of the seller as well as the "Perceived transparency".

During this process, users continue with the interaction task only when the mental model is clear enough and the different criteria are fulfilled. Interaction tasks are not to be considered independent and separated, but complementary. In order to reach the goal, confidence and trust must be generated.

The most important innovation of this research is the focus on the whole interaction, on its tasks and the creation of a mental model, rather than only on the result of the interaction process (trust or distrust).

The second phase of the research is to obtain qualitative and quantitative data in order to validate the model and to generalize it to various contexts: telemedicine, on-line psychological counseling and therapy.

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Presenter: Azucena García-Palacios, Ph.D.

Comparing The Acceptance of VR Exposure vs. In vivo Exposure in a Clinical Sample

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Phobias are one of the most common mental disorders. It is estimated that about 11% of the US population suffers from a specific phobia, and around 6% suffer from agoraphobia according to epidemiological studies (National Comorbidity Survey; Magee, Eaton, Wittchen, McGonagle & Kessler, 1996). Exposure therapy is a well-established treatment for phobias. There are different modalities of exposure therapy. The most successful and commonly used is "in vivo" exposure. This technique offers high success rates (75-95% of patients clinically improved) and long-term effectiveness (one-year follow-up). Because of this, "in vivo" exposure is considered to be the treatment of choice for specific phobia. However, despite the fact that phobias can be successfully treated, very few phobics ever seek treatment. It is estimated that only 15% seek treatment (Boyd et al., 1990). Aside from the low percentage that seek treatment, around 25% either refuse the "in vivo" procedure or drop out (Marks, 1992). The main reason patients refuse "in vivo" exposure is that they are too afraid to confront the feared object or situation. Because of this, we think that although "in vivo" exposure is an effective treatment, new efforts are needed to increase the number of phobia sufferers who seek and successfully complete the treatment.

Making the treatment less intimidating would be a good start. We think that VR can help to achieve this goal. VR exposure has some advantages over "in vivo" exposure that may make it less aversive and more attractive to phobia sufferers. The main advantage is the high level of control over the feared object. In VR, the feared situation can be more easily and more accurately graded. VR also allows for easier repetition of the exposure tasks. Finally, it is possible to carry out exposure without leaving the consultation room, assuring more confidentiality. We think that patients who are reluctant to start an "in vivo" program may be more willing to get involved in a VR treatment. In a former study, we surveyed a sub-clinical phobic sample. The results showed a higher degree of acceptance of VR exposure vs. "in vivo" exposure (García-Palacios, Hoffman, Kwong See, Tsai, A. & Botella, 2001). The present study surveyed 102 patients who met DSM-IV criteria for spe-

cific phobias (animal type, situational) or panic disorder with agoraphobia (a clinical sample). When asked to choose between "in vivo" exposure vs. VR exposure therapy, 70% chose VR exposure. 23.5% refused in vivo exposure whereas only 3% refused VR treatment. This is the first survey that offers data of acceptance and refusal rates of in vivo exposure vs. VR exposure in a sample of clinically phobic individuals. Our findings suggest that VR exposure therapy may prove valuable for increasing the number of phobics who seek treatment and for decreasing the "in vivo" exposure refusal rates. VR exposure can help to improve the efficacy achieved by one of the most important techniques in the treatment of anxiety disorders, exposure therapy.

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Presenter: Jeff G. Gold, Ph.D.

A Controlled Study of the Effectiveness of Virtual Realty to Reduce Children's Pain During Venipuncture

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Research Status: In progress.

Background/Problem:
Attention plays an important role in perception of painful stimuli, and several studies have identified the efficacy of distraction for reducing pain among children who must undergo invasive medical procedures. Numerous methods of distraction have been evaluated and recently, virtual reality (VR) was identified as a potentially effective tool for pain distraction. Due to its highly involving nature, VR may mediate painful stimuli by engaging the user and placing significant demands on the limited cognitive resource of attention. VR has shown promise as a non-pharmacological pain management tool with several populations and medical procedures. One frequently required painful procedure is venipuncture. This procedure involves piercing a vein with a needle for the purpose of a blood draw. Despite its relatively routine nature, venipuncture has been reported to be among the most feared hospital experiences for child patients.

Method/Tools:
This study presents preliminary data on the effectiveness of VR as a child pain distracter during a blood draw. Children (8-12 y/o) arriving at the phlebotomy laboratory at Children's Hospital

of Los Angeles for the purpose of a blood draw were recruited. Participants completed baseline measures and were then randomly assigned, stratified for age and gender, to have their blood drawn in one of four conditions: a control condition (without distraction), cartoon distraction, distraction by a VR scenario presented on a flat-screen computer, and the same VR scenario presented in a head mounted display system. Visual perception of the needle was controlled across all conditions by a visual occlusion. Child self-reports of needle pain, parent and phlebotomist reports of child pain, and parent and child state anxiety were measured. In addition, children completed a measure of presence and simulator sickness symptoms.

Results:
Preliminary results on 57 participants found that children distracted by VR reported significantly less affective pain than children in the cartoon or flat-screen VR distraction groups. Significant differences between conditions were not found for child or parent anxiety; nor were they found for parent or phlebotomist ratings of child pain. A significant negative correlation was found between child rating of presence and self-reported pain, supporting the theoretical connection between degree of involvement and mediation of pain. No child reported significant levels of simulator-related side effects.

Conclusion:
Although these are preliminary findings on half of the full data set, this study is consistent with previous studies exploring the potential of VR for non-pharmacological pain management. The current study extends previous findings to 8-12 year-olds undergoing venipuncture and supports the pain management potential of this evolving technology. As technological advances in VR continue with resultant enhancements of the experience of presence, virtual reality may turn pain into a virtual unreality.

Novelty/Discussion:
The current research is novel in that it uses a between groups design to test the effects of VR across display conditions (HMD vs. Flatscreen), compared to passive watching of a cartoon and standard care in children. However, we have also added to standard care, a physical barrier so that the pain site is occluded from the child's vision. This more conservative test controls for visual occlusion across all conditions (the barrier was used in all groups) and will tell us if the actual attentional component of VR has pain distracting effects BEYOND what we might observe by simply having the subject wear a blindfold! Basically, we know VR works in this application area, but we need to begin isolating the components that are active ingredients, so that we can design cost effective systems with the highest level of positive impact.

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Presenter: Ken Graap, M.Ed.

Treating Fear of Flying in Virtual Reality: A Controlled Study

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Research Status: Completed; being prepared for publication

Background:
Standard Exposure (SE) is considered the standard of care in treating specific phobias. However, SE can be difficult to arrange for fear of flying, especially after the events of 9-11-01. Difficulty gaining access to airport facilities and equipment to conduct SE, difficulties associated with conducting treatment in public locations and the costs of accompanying persons on flights can make SE untenable. Virtual Reality Exposure (VRE) offers significant advantages in the treatment and research of anxiety and other

disorders. Virtual Reality (VR) allows users to interact in various ways within a computer-generated virtual world. Use of Head Mounted Displays (HMD's), motion trackers, and vibration platforms allow one to experience the virtual world as one would experience the real world, resulting in a sense of presence or immersion in the virtual world. VRE's have been utilized in the clinical treatment of anxiety disorders since approximately 1992 (for a review see Anderson, et al, 2001, Bulletin of the Menninger Clinic, 65, 78-91).

Method:
Seventy-five participants who met DSM-IV criteria for specific phobia (fear of flying) completed treatment after being randomly assigned to VRE, SE, or WL. WL participants were also randomly assigned to either VRE or SE treatment after serving as controls. Random assignment, use of a standardized treatment manual, homogenous inclusion criteria, and blind independent assessment are features of this methodologically rigorous study.

Treatments were delivered in 8 individual sessions across six weeks. VRE and SE groups received identical treatment for sessions 1-4, including assessment and anxiety management skills training. During sessions 5-8, participants engaged in exposure therapy, either at the airport (SE) or in the therapist's office using the virtual airplane (VRE). After completion of treatment, participants were offered the opportunity to take a graduation flight. During the flight, anxiety measures were collected.

Results:
Results indicated that VRE and SE did not differ on standardized questionnaires, willingness to fly, anxiety ratings during flight, self-ratings of improvement, nor patient satisfaction with treatment. Both active treatments were significantly better than WL, which showed no difference from pre- to post-treatment.

Six and twelve month follow up data indicated that participants maintained gains made during treatment. Both groups had similar numbers of respondents and repeated measures ANOVA analyses did not reveal differences between the treatment groups during follow up.

Conclusions:
The findings support the use of virtual reality exposure for treatment of fear of flying. Exposure *in vivo* did not differ from exposure in VR immediately post treatment, 6 months, or 12 months post treatment on any outcome measure, including standardized questionnaires or a behavioral avoidance test (graduation flight). VRE offers significant advantages in terms of treatment logistics and efficiency without sacrificing the efficacy of SE. Importantly, VR allows treatment to be conducted in the privacy and convenience of an office setting, more control over stimuli, easy repetition of feared scenes, and the opportunity to standardize exposure to a variety of cues across locations.

Novelty:
This study is the largest, controlled study of VRE for fear of flying to date. (497)

This research was supported by NIMH Grant #R42-MH58493-02

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Presenter: Dr. Michael R. Heim, Ph.D.

Avatar Diplomacy

Research is in progress to use VR for relieving psychological damage suffered by children growing up in war zones. The "pen pals" movement fostered a feeling of international connection and friendship in school-age children, which mitigated the feeling of fearful isolation induced by World War II. While the pen pals movement helped previous generations connect by using pen-and-paper letters exchanged through con-

ventional postal services, today's youth are engaged in video games and avatars on the Internet. "Avatar Diplomacy" is the guided use of networked virtual environments to connect school-age children through culturally customized avatars in specially designed virtual worlds. The first phase of this project began with research on the aesthetics of Internet virtual worlds conducted from 1997-2001 at Art Center College of Design in Pasadena, California. Results from this study were presented in several places including VRST 2000 (Seoul, Korea), *Computer Graphics World (January 2001), SIGGRAPH 2000, and at* UNESCO in Rio de Janiero (May 2003).

What emerged from the first phase of research was a model of avatar encounters that is not restricted to role-playing games (e.g. *EverQuest), nor based on rule-based* behavior like most computer video games. The model is not one of competition but one of encountering alien avatars and exploring their features. The model relies on the use of a series of meetings that are highly focused events (each one-hour long) guided by skilled moderators who host the avatar encounters.

The next phase of the project addresses the deployment of a handful of geographically dispersed nodes on different continents where moderated avatar encounters can be launched from participating schools. The results from this phase will determine the shape of the final project to be implemented in international conflict zones. This intermediate phase seeks to establish the role of visualization techniques in customizing avatars. At Beach Cities Health and Healing Center (www.bchd.org), the classes both in Meditation and in Tai Chi use a sequence of body-based visualizations to effect the shifts in perception, breathing, and a sense of well being. While these classes draw on Patricia Carrington's research into Clinically Standardized Meditation (CSM), the visualization techniques used at BCHD are Taoist projections of the imagined physical body. Such image projections share many characteristics with avatar self-projection in virtual worlds.

The upcoming phase of research seeks to determine which imaginative projections work most effectively for the implementation of avatar diplomacy. This phase tests the responses of the first nodes of users to determine the most appropriate avatar designs and activities that will underpin the later implementation of avatar diplomacy. Tools in this phase will be widely available 3D software such as ActiveWorlds Universe and Adobe Atmosphere 3D. As in previous experiments, users will receive instruction on how to design their own avatars using *Avatar Lab, a subset of Poser software* (www.curiouislabs.com).

[Note: Many of these references are available on the Web. See links at www.mheim.com under "Articles" and "Books".]

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Presenter: Patricia Heyn, Ph.D.

Virtual Reality Therapy: A Systematic Review of the Effectiveness of Interventions

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Research Status: In progress

Background:
For the past decade the number of new studies being published on the proposed applications of Virtual Reality Therapy (VRT) for rehabilitation has increased exponentially. The literature supports the benefits of VRT in the improvement of a wide range of physical, mental, or behavioral disorders.

Problem:
Although there is evidence to support the positive benefits of VRT, there are no studies that systematically review the level of evidence of VRT interventions. The widespread application of such interventions should be preceded by evidence of directly attributable improvements on the desirable physical, mental, or behavioral outcome.

Aim:
The purpose of this study is to quantitatively review the published literature to determine whether VRT is a beneficial therapeutic tool to

improve physical, mental, or behavioral disorders.

Methods & Data Sources:
A database from 1980 to July 2003 of published and non-published manuscripts will be compiled by using MEDLINE, PUBMED, CINAHL, PsycInfo, Psyc-Lit, Educational Resources Information Center (ERIC), Rehabdata, PEDro, NIDRR, the Cochrane Controlled Trials Register, Dissertation Abstracts, and the reference list of identified studies and other reviews will be examined. Key words that will be used in the search are virtual reality, virtual environment, and computer-assisted combined with therapy or rehabilitation, or intervention. Additional key word combinations include cognitive, mental, physical, activity, exercise, fitness, movement, occupational, disorders, neurological, psychiatric, pediatric, behavior, psychological, impairment, function, and disability. Articles not written in English will be excluded.

Study Selection:
To be selected for detailed review, reports have to meet the following criteria: (1) evaluate the effects of a VRT intervention (rehabilitation or therapeutic program) on physical, mental, or behavioral outcomes, (2) describe the clinical population, (3) describe the outcome measures, and (4) report enough data for meta-analysis.

Data Extraction:
Studies that meet the inclusion criteria will be analyzed for methodological quality and for relevant effect size calculation.

Data Synthesis:
For each selected outcome, summary effects will be computed by pooling standardized mean differences as well as raw mean differences. Frequencies and descriptive statistics will be reported.

Results:
Results will be reported on effect size index and confidence intervals. In addition, descriptive information about moderator variables; the type of VR therapy, duration and level of exposure, clinical population, and mode of VRT will be presented.

Key Words:
Virtual reality, virtual environment, therapy, rehabilitation, mental, psychological, physical, psychiatric, behavioral, cognition, functioning.

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Presenter: Kay Howell, Ph.D.

Advances in Using Simulations to Train Complex Decision-Making in Teams

Advances in cognitive science research have provided great insight into how people learn and recommendations for improving learning outcomes. As a result, there has been a proliferation of instructional design theories and models for education and training. While there are numerous theories and models – many of which use different terms – there are fundamental underlying principals which many have in common. For example, cognitive science has long recognized that learning environments that provide opportunities for learners to apply their knowledge to solve practical problems can lead to faster learning, greater retention, and higher levels of motivation and interest. Simulations that allow learners to visualize complex phenomenon and/or provide opportunities for practice and experimentation have proven very effective. Simulations offer a number of advantages compared to training with actual equipment or in the actual job environment. They can be used as practice environments for tasks that are too dangerous to be practiced in the real world. Simulations can provide increased opportunities for practice on tasks that occur infrequently (e.g., emergency procedures) and they can be used when actual equipment cannot be employed. Simulations can contain embedded instructional features (e.g., feedback) that enhance the instructional experience. Simulations can also represent significant cost savings compared with training on operational equipment. Modern technology is providing increased opportunities to deploy simulations that allow team members who are physically dispersed to train together over a network. Unfortunately, apart from military applications and a few selected industries (e.g., pilot training),

simulation-based training is rarely used today because it is difficult to implement in standard instructional environments. Expected improvements in technology, however, have the potential to significantly reduce the cost and complexity of implementing learning-by-doing environments. The combined forces of high-powered computing, unparalleled bandwidth, and advances in software architecture are poised to make realistic gaming and simulation environments more feasible and economical. Because these tools will be increasingly available, it is important to understand appropriate contexts and methods for implementation.

This session will explore the use of modeling and simulation to enhance team decision making and performance based on theoretically driven, empirically based guidelines. Teams are used with growing frequency by modern organizations, ranging from business decision-making to national security matters. The complexity and scope of issues to be addressed often require the efforts of multiple people working together. Thus, the performance of teams and their decision-making abilities have a great impact on the success of organizations. The panel will summarize recent research progress toward understanding decision-making in teams, including research on competencies, tools and instructional strategies that contribute to team performance. Technologies used to validate the fact that realistic simulations provide a highly effective way to train complex decision making skills will be examined. The panel will conclude with a discussion of issues and trends related to simulation, including how to make them easier to build and incorporate into learning environments, as well as describe some the current uses of simulation in team training.

Presenter: Ho-Sung Kim, Ph.D.

A functional Magnetic Resonance Imaging (fMRI) Study of Nicotine Craving and Cue Exposure Therapy (CET) by using Visual Stimuli

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Research Status: In Process

Objective:
Cue Exposure Therapy (CET) refers to the manual, repeated exposure to smoking-related cues aimed at reducing cue reactivity by extinction. Traditionally, pictures or real objects have been used for CET. In our previous research, comparing the changes of craving before and after exposure to Virtual Environment (VE) and still photos, the increase of craving with VE versus pictures was shown to be significantly larger [1]. However, this previous study used subjective questionnaires to measure the changes. In this study, we are planning to find objective evidence of VE's effectiveness in CET using functional Magnetic Resonance Imaging (fMRI). For this, we constructed a VE for drawing one's desire of nicotine based on the results of the previous study, and compared the activation maps from the VE and moving pictures using fMRI.

Method:
20 subjects who are right handed are going to be recruited and divided into two groups. One group will be exposed to VE and the other to moving pictures. Each subject will be required to fill out a questionnaire that asks for the subject's level of nicotine craving before and after the experiment, so that the changes can be observed. A 1.5 T GE MRI machine in Hanyang University Kuri Hospital, Korea, will be used to gather fMRI data and a subject in the magnet will be able to see a visual stimulus (VE or moving pictures) through MR compatible HMD (Resonance Inc.). The block design will be used and the data will be analyzed with SPM99.

Results:
Although the experiment and the data analysis are still in progress, we are able to predict that the areas which are involved in the process of the visuo-spatial attention, memory, and craving would be activated, such as right intra-parietal sulcus, posterior hippocampus (bilateral), medial thalamus (bilateral), right ventral tegmental

area, right posterior amygdala, right inferior frontal gyrus, and middle frontal gyrus (bilateral) [2] and these areas are more activated in VE session.

Conclusion:
We proposed a VE that can be used in CET to induce nicotine craving, and our results would show stronger brain activations in VE than those in moving pictures. It might be able to support the belief that Virtual Reality (VR) is a more effective method of CET. VR can provide a multi-modal environment that requires one's cognitive ability such as spatial attention and memory in order to interact, causing a higher level of craving.

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Presenter: Hunter Hoffman, Ph.D.

Virtual Reality analgesia during thermal and electrical pain for longer durations, and multiple treatments

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Research Status: Completed

Preliminary clinical evidence suggests that at least for brief (3-6 minute) treatment durations, Virtual Reality is surprisingly effective for reducing extreme pain. VR has reduced pain by as much as 50% during brief burn wound care and physical therapy treatments. The present laboratory pain pilot study introduced a new laboratory pain paradigm combining thermal and electrical pain to allow the study of longer pain sessions. We explored whether VR works for longer durations with multiple treatments per subject. The virtual environment titled SnowWorld was used. Aiming with her head-position-tracked gaze, the subject shot snowballs at snowmen, igloos, robots and penguins by pressing a button. During each session, four thermal pain stimuli lasting thirty seconds each were interleaved with four electrical pain stimuli lasting two minutes each, administered over a period of 25 minutes. Using subjective 0-10 graphic rating scales, after each brief stimulus, our healthy 19 year old female volunteer rated three aspects of her pain: 1) the amount of time spent thinking about pain, 2) pain unpleasantness, and 3) worst pain. Comparing thermal pain during baseline (no VR) to mean thermal pain during VR treatment, "time spent thinking about pain" dropped from 9 to 2.5, "pain unpleasantness" dropped from 9 to 2.5, and "worst pain" dropped from 9 to 3.2. Comparing electrical pain during baseline (no VR) to mean electrical pain during treatment (during VR), "time spent thinking about pain" dropped from 9.5 to 1.25, "pain unpleasantness" dropped from 8 to 3, and "worst pain" dropped from 7.5 to 3.4. This pattern of strong pain during "no VR" baseline and large drops in pain ratings while in VR was replicated on several subsequent days for the one subject who received VR. Four control subjects received no VR at all. As predicted, they showed high pain ratings during baseline and throughout their 25 minute sessions, and this pattern of consistent, high pain ratings was found on all six 25-minute sessions per control subject. While small studies are inconclusive by

nature, these results are encouraging preliminary evidence that VR reduces pain for longer (clinically relevant) treatment durations, and VR analgesia appears to remain effective with repeated use. Simulator sickness was negligible for this subject, and her rating of presence in VR was consistently "strong". A larger controlled laboratory study is currently underway.

Novelty/Discussion:
This is the longest duration of VR analgesia by our group to date and introduces a new technique for safely inducing multiple etiology (thermal and electrical) laboratory pain for prolonged treatment periods.

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Presenter: Jeonghun Ku, M.S., Ph.D. Candidate

A study of Brain activations and Presence in a Virtual Touching Task using fMRI

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Research Status: Preliminary results

Background:
It is often that we attempt to measure cognitive processes within the context of a virtual environment (VE), such as complex sensory processing, attentional ability, spatial cognition and memory. Collectively, these contribute to and influence the "feeling of presence." In this study, we investigated the relation between presence and brain activation using functional magnetic resonance imaging (fMRI). We hypothesized that the activity in brain regions responsible for sensory integration, as well as attention processing, could be influenced by changes in presence score. This was based on the conceptual model that VE enrichment through use of multimodal stimuli could enhance the feeling of presence. To test the hypothesis, we designed an fMRI-compatible data glove that can provide vibrotactile stimulation, and performed fMRI experiments to investigate the changes in brain activity and presence score produced by touching a virtual object with and without vibrotactile feedback.

Methods:
Four young, healthy, right-handed subjects (1 male, 3 female, average age is 25.25 (sd=3.86)) underwent fMRI at 3.0 Tesla magnetic field strength. They experienced 7 tasks in pseudorandom order: "see" virtual object, "feel" vibrations, self-paced finger "tapping", "touch1 and touch2" (touch virtual object with / without vibrotactile feedback), and "touch3 and touch4" (touch a vibrating virtual object with / without vibrotactile feedback). Brain activity for the group was assessed in a mixed-effect analysis. Using a photo-plethysmograph mounted on the MRI system, heart rate variability (HRV) data was recorded throughout and analyzed to yield the low frequency to high frequency ratio (LF/HF) as a representation of arousal. After fMRI, the subjects completed questionnaires to assess their subjective level of presence (0 to 10) in each task.

Results:
Mean presence scores tended to be higher for tasks that included vibrotactile feedback compared to those that did not. Mean LF/HF ratios showed a similar effect. For all "touch" tasks, left precentral gyrus (primary motor area), inferior parietal lobule, medial frontal gyrus, and occipital lobe showed activity. Areas known to be involved in sensory integration and attention processing (left anterior cingulate, left middle frontal gyrus, and right insula) showed changes in activity between touch1 and touch2 tasks, and between touch3 and touch4 tasks.

Conclusion:
In this study, consistent changes in HRV and brain activation were observed, related to different feelings of presence in a virtual touching task, and linked to the processes of sensory integration and attention. Further investigation,

including a larger number of volunteers is required. Nonetheless, these preliminary results support the notion that the observed brain activation is consistent with a component of the conceptual model of presence, i.e. "system enrichment," which can draw one's attention and increase one's involvement and feeling of presence. Such experiments additionally provide an important window on the ecological validity of VR applications in clinical psychology.

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Presenter: Jang Han Lee, Ph.D.

Design and Implementation of Virtual Reality System to Assess and Train the Patients of Unilateral Visual Neglect

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Research status: In Progress

Objective:
The aim of this study is the implementation of a virtual reality (VR) system that can assess the state of disease and train the hemispatial neglects to affect visual stimulation. The virtual environment provided by the system is maternalized with 3-dimensional computer graphics, which is similar to the branch road. There is a target ball which guides subjects' gaze while the target ball moves randomly to the right or left from the user's viewpoint. In this experiment, the patients should chase the movement of the ball. The task level is utilized in order to assess the patients' characteristics from this result. The training task level is predetermined.

Method/Tools:

System:
The VR System consists of Pentium IV PC, DirectX 3D Accelerator VGA Card, HMD (Eye Trek - OLYMPUS), and 3DOF Position Sensor (Intertrax2) The PC with 3D Accelerator VGA Card generates real-time virtual images for subjects to navigate. The position sensor transfers a subject's head orientation data to the computer.

Virtual environment:
We built the branch road so that the ball is located in the center of the road. The subject's gaze is guided as the ball moves in a random direction. The ball changes color if the patient looks at the ball. This change awakens the visual attention of the patient.

Tasks in the Virtual Environment:
Our program is composed of 3 stages with 4 levels for differentiating the training according to the characteristics of the patient. The level is distinguished by the speed of the ball. If the patient succeeds at the same level three times, then the patient moves on to the next level. There are 3 cues in one level and each cue happens according to each time passage. Patients pass to the next stage if they succeed in all four levels. The 3 stages are divided by visual angle.

Results:
Left side neglect patients show a neglect expression angle more deviated toward the left side than normal subjects. This result supports the correlation of the VR system with neglect evaluation tools such as the line bisection test and the letter cancellation test. Attention time and scanning time are increased in the left side neglect patient who has a deficit in attention, midline orientation, and neck rotation ability. If a patient steadily performs the training program, we expect that the symptoms of the patient will improve.

Novelty/Discussion:
The VR system has more benefits than previous neglect evaluation tools. This system provides high ecological validity by 3-dimensional computer graphics that are similar to the real world, and assesses data that can be acquired while the patient reacts immediately to various stimuli. The data is used to diagnose the condition of the patient. However, statistical analysis about

the data is difficult because subjects are scarce. Thus, we will progress the clinical test continually in the patients with unilateral neglect.

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Presenter: Fabrizia Mantovani, Ph.D.

Narrative Dimension, Sense of Presence and Emotional Involvement: An Experimental Analysis

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Research status: In Progress

Background:
A number of studies in the field [1] have clearly shown that Virtual Reality (VR) can be a powerful tool within a psychotherapeutic intervention. In particular, a critical feature for a clinical Virtual Environment, now under investigation by the European Project EMMA – Engaging Media for Mental Health Applications (http://www.emma.upv.es/), is its ability of inducing presence and emotions in users [2]. A recent model of presence [3] described it as a defining feature of self, related to the evolution of a key feature of any central nervous system: the separation between an external world and the internal one. If in simple organisms, this process involves only a correct coupling between perceptions and movements (movement tracking), in humans it also requires the shift from meaning-as-comprehensibility to meaning-as-significance, with meaning-as-significance refering to the value or worth of the event for us. For a patient, "his/her events" are only the ones that are meaningful for him/her. Following this vision, an important role for inducing a high level of presence could be played not only by system-related features such as graphic realism, level of immersion and interaction devices, but also by the setting of the VR experience within a meaningful narrative context, favoring user identification and involvement. However, few systematic and controlled studies aimed at investigating the complex relationships of these dimensions have been carried out.

Method/Tools:
The main objective of the presented research is the study of the influence of narrative dimension and level of immersion on sense of presence, emotional involvement and psychophysiological arousal, within a virtual reality experience. 40 subjects (female university students between 20 and 25 years old) took part in the study. Experimental design (a 2x2 between subjects design) included two independent variables: 1. presence vs absence of narrative context and 2. immersive (Head-Mounted Display) vs non-immersive condition. Dependent variables were sense of presence, measured through ITC-SOPI questionnaire [4], emotional experience measured through Positive and Negative Affect Scale (PANAS) [5], and psychophysiological indexes such as heart rate (HR) and galvanic skin response (GSR).

Conclusions:
Preliminary data support the vision of VR as an *advanced imaginal system*: an experiential form of imagery that could be as effective as reality in inducing emotional responses. The possibility of structuring a large amount of real-like or imagi-

nary controlled stimuli and, simultaneously, of monitoring the possible responses generated by the user of the virtual world may offer a considerable increase in the likelihood of therapeutic effectiveness, as compared to traditional procedures. However, the data also suggest that the clinical skills of the therapist and in particular, his/her ability in creating a narrative context (clinical protocol) for the experience, remain a critical factor for the successful use of VR systems.

The present work is supported by the European Commission, in particular by the IST program: Project EMMA- Engaging Media for Mental Health Applications, EMMA (IST-2001-39192), http://www.emma.upv.es. We are grateful to all our partners in the project for their contribution in developing the ideas presented in this work.

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Presenter: Melanie Michaud

Manipulating Presence and Its Impact on Anxiety

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Research status: Almost complete

Background:
Current studies in our lab, as well as those at other centers, have reported significant correlations between presence and anxiety. But the direction of the causal relationship between the two constructs remains to be tested: does presence in VR lead to anxiety, or does anxiety lead to presence in VR? The aim of this study is to experimentally manipulate the sense of presence to test the level of anxiety felt by phobics when immersed in a virtual environment.

Method:
The sample consisted of 40 people afraid of heights who had to perform a feared task for 10 minutes while immersed on a virtual bridge. The task involved contemplating a 15-story building under construction, selecting which floor to exit, taking the elevator to the selected level, exiting the elevator and walking on a scaffold crossing the streets, hit a plank and watching it while it falls, see an airplane and turn back.

The participants were randomly assigned to two conditions: (a) High Presence First (High-PF; the task was conducted in a setting that maximized presence), and (b) Low Presence First (Low-PF; the task was conducted in a setting that disrupted presence). The study used a repeated measure factorial design where the

tasks were performed once in each setting, in a reversed order between the conditions (High-PF and Low-PF). To maximize presence, participants were immersed in VR with a dark cloth covering a Cy-Visor HMD, in a dark and quiet room. In the other setting, the HMD was not covered by a black cloth (participants could see the room around them), the lights were turned on and music was playing in the background.

The following questionnaires were used: the Immersive Tendencies Questionnaire (assessing subjects' predisposition to feel immersed in VR), the Simulator Sickness Questionnaire (measuring cybersickness), the Presence Questionnaire, the State-Trait Anxiety Inventory and the Acrophobic Questionnaire.

The equipment used includes: an *IBM Pentium IV*[MD] computer and an *ATI-9700* graphics card. A *Cy-Visor* with a big resolution (1.44 millions Pixels) and an *Intertrax-II* tracker by *Intersense* were also used. Finally, the virtual environment was created using the Max Payne 3D game editor. A 15-floor building constitutes the environment where the subject can take an elevator.

Results and Conclusions:
Our results showed that subjects are more anxious in the High presence condition. This is interesting in the context of other results in our lab suggesting that anxiety also affects presence. Thus, there seems to be a synergistic effect between anxiety and presence. Further studies should assess whether this effect also applies to other emotions (e.g., sadness, joy) and if the synergistic effect follows a linear relationship or is subjected to floor and ceiling effects.

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Presenter: Matthew Parrott

A Methodology for Designing Specific Animal Phobia Stimuli for Virtual Reality Exposure Therapy

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2 Department of Psychology, Virginia Tech

Research Status: In Development

Background/Problem:
To effectively treat phobias, therapy techniques must be capable of producing an emotional response within a patient (Foa, Steketee, & Rothbaum, 1989). A sense of presence induces anxiety when using virtual reality exposure therapy, even when there is no actual threat (Rothbaum, Hodges, Watson, Kessler, & Updike, 1996). To maintain presence, virtual stimuli must replicate the complexities, scale, and appearance of real world stimuli (Rothbaum & Hodges, 1999). Because of the constraints of real-time systems and production requirements, stimuli attributes must be prioritized and abstracted. However, no systematic approach to creating virtual stimuli currently exists. Our presentation demonstrates a potential design methodology within the context of a larger project treating snake phobia through virtual exposure therapy.

Methods/Tools:
The methodology follows an iterative approach of prioritizing, abstraction, modeling, and evaluation. Prioritizing involves analyzing the real-world stimulus along with exposure therapy data to identify key fear-inducing features. During abstraction, simplified design analogies distill these key elements into manageable concepts. A system is then modeled around these analogies to reproduce the stimulus within the virtual environment. Finally, phobic patient testing evaluates the believability of the stimulus. Key elements that need to be added or improved are considered, and the iterative process is continued until an acceptable level of anxiety production is achieved.

Novelty:
Key elements identified within the real-world stimulus included locomotion, tongue flicker, decision-making, interaction with objects, and scale patterns. Phobic patients often commented that the way a snake moves is a major factor in inducing fear. Accordingly, priority was placed upon the movement model used. A spring and mass analogy was used to approximate the muscles used in the snake's movement. Synthetic intelligence techniques were

used to produce realistic behavior while maintaining therapist control. While previous animal phobia treatment VEs included animated animal stimuli (Garcia-Palacios, Hoffman, Carlin, Furness, Botella, 2001), they did not include behavioral algorithms. Stochastic patterns enhanced the organic quality of many features, such as the timing of the flickering tongue. The therapist was also given control over key behavior animations, such as the snake raising its head and smelling the air to gather information about the environment.

Conclusion/Results:
Using a systematic approach produces virtual stimuli, which are effective in generating fear in patients with specific animal phobias. Test subjects reported fear levels as high as nine on the Subjective Units of Discomfort (SUD) scale. In addition, four broad areas of design heuristics emerged. These include the stimulus' appearance, movement, behavior, and interaction. Behavior is distinguished from interaction in the sense that behavior is object intelligence while interaction implies some form of input from a user or the environment.

It is vital that the object react naturally with the environment and vice versa. Although the snake does not appear entirely realistic to the non-phobic user, it does exhibit the key qualities that induce fear, making it appear far more realistic to phobic patients. Thus, proper prioritization of attributes allows for a more effective stimulus design.

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Presenter: Matthew Parrott

An Immersive Virtual Environment for the Treatment of Ophidiophobia

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2 Department of Psychology, Virginia Tech

Research Status: In Development

Background/Problem:
Virtual reality exposure (VRE) therapy has been shown to be an effective treatment for specific phobias VRE (Rothbaum & Hodges, 1999). This project uses VRE in the treatment of ophidiophobia (fear of snakes). The reproduction of the effectiveness of graded exposure therapy required a comprehensive gradation of exposure and therapist input to tailor the environment for the needs of specific patients.

Methods/Tools:
Our team developed Snake Phobia SVE using the Simple Virtual Environment Library (SVE). SVE is an application programming interface (API) (Kessler, Bowman, & Hodges, 2000) that allows researchers to rapidly develop immersive virtual environments. It includes useful extensions for controlling hardware such as head-mounted displays (HMDs), tracking systems, and input devices. Richly detailed environments were created to maximize the patient's sense of presence and thereby improve the success of the VRE (Rothbaum & Hodges, 1999). A unique device produced by Measurand known as the ShapeTape allows users to hold and manipulate a virtual snake. The ShapeTape consists of a long plastic strip embedded with fiber-optic sen-

sors. The virtual snake duplicates the ShapeTape curvature.

Novelty:
Designing realistic stimuli was a major focus of the project. Combining synthetic intelligence, physics based movement, advanced modeling and texturing, and therapist control, we created a stimulus that was effective within the constraints of a real-time system.

Previous VRE environments have made use of tactile props to enhance emotional response (Garcia-Palacios, Hoffman, Carlin, Furness, Botella, 2001). The input of the props is often limited to position tracking. Our project extends the idea of a prop as an input device with the ShapeTape. Our application is unique because the articulation of the prop is duplicated within the environment.

Because the user is under stress, a system of navigation needed to be developed to allow the user to move freely and accurately even when in fear. We used a system of collision detection and control paths to allow the user to move freely yet remain in desired areas.

The first scenario involves patients viewing graded posters of snakes in a museum setting. Then the patient progresses through a scenario featuring snakes in three glass cages. Each snake is larger and more aggressive than the last. The next scenario occurs outdoors in a nature trail setting. Here, the graded attribute is the confrontation style; patients must confront the snake in increasingly uncontrolled ways. The final scenario requires the patient to actually handle the snake through a tactile prop. Such a wide range of interaction is generally not exhibited in VRE applications.

Conclusion/Results:
A pilot user test found the environment effective in stimulating intense fear in a near-phobic patient. The therapist also found that the system complemented existing exposure techniques, supporting the theory that producing a robust environment allows for a comprehensive treatment scheme. Current work includes designing an interface for the therapist, adding ambient sound, and conducting clinical trials to empirically determine effectiveness.

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Presenter: Patrice Renaud, Ph.D.

The Recording of Oculomotor Responses in Virtual Immersion: A New Clinical Tool to Assess Approach and Avoidance Behavior Dynamics

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Research status: In progress.

Background:
Virtual reality (VR) therapy relies heavily on what patients pay attention to in immersion. Because the content of the attention's focus is so central in the use of VR as a way to induce therapeutically relevant psychological states, it

appears obvious that controlling what intervenes in the perceptual motor loop is important. We developed a method that controls oculomotor activity relative to selected virtual objects' visual features. Moreover, we are applying this method to study approach and avoidance behavior dynamics, i.e. fluctuations of the oculomotor responses as a function of time. Two separate studies are conducted using our method, one aiming at assessing avoidance behavior with arachnophobic subjects facing virtual spiders, and another aiming at assessing sexual preferences with subjects of different sexual orientations interacting with virtual naked models.

Methods:
Our method relies upon a technological setting including what is usually necessary to present virtual environments in immersion, as well as equipment dedicated to eye-movement tracking from within a head mounted display (HMD). A special mounting built from a monocular infrared eye-tracking system, combined within a binocular HMD, is used to track eye-movements. Head-movements are recorded from a magnetic tracking system rendering the 6 degrees-of-freedom (DOF) of translation and rotation. Our method performs gaze analysis by the way of virtual measurement points (VMP) placed on virtual objects for the analysis of eye-movements in relation to specific features of these objects. Gaze radial angular deviation (GRAD) from the VMP is given by the combinations of the 6 DOF developed by head-movements and the x and y coordinates rendered by the eye-tracking system. The VMP is locked to virtual objects and moves jointly with them. While the variations in the 6 DOF developed by head-movements define changes in the global scene presented in the HMD, the 2 DOF given by the eye-tracking device allow the computation of the exact position of the line of sight relative to the VMP. As other physiologic signals, we also measure the subject's distance from the VPR, the pupil size diameter and the blinking response.

The 3D stimuli that we used are virtual spiders (in the arachnophobia study) and naked human models (in the sexual preferences study).

Results:
Preliminary results from the arachnophobia and sexual preferences studies will be presented. These results will consist in analyses performed on time series coming from oculomotor responses recorded in immersion.

Novelty:
These results inscribe themselves in the extension of our past studies whose goal was mainly to make sense of the perceptual and motor dimensions of virtual immersion (Renaud et al., 2001; Renaud et al., 2002 a, c). Nevertheless, they help to circumscribe more precisely the perceptual motor dynamics by adding measures of oculomotor activities and by looking at how these measures relate to the valence and affordance of virtual stimuli (Renaud et al., 2002 b; Renaud et al., 2003).

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Presenter: Giuseppe Riva, Ph.D.

The VRTherapy Project: Free Virtual Reality Tools for Mental Health Therapists

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Research status: In Progress

Background:
In the last five years there has been a steady growth in the use of virtual reality (VR) in health care due to the advances in information technology and the decline in costs. Much of this growth however, has been in the form of feasibility studies and pilot trials. Why is the impact of VR in health care still so limited? There are three possible answers. First, there is a lack of standardization in VR devices and software. Secondly, there is a similar lack in standardized protocols that can be shared by the community of researchers. If we check the clinical literature, we can find only four published clinical protocols: for the treatment of eating disorders (1), fear of flying (2), fear of public speaking (3) and panic disorders (4). Finally, the costs required for the set-up trials are somewhat daunting. According to the European funded project VEPSY Updated, the cost required for designing a clinical VR application from scratch and testing it on clinical patients using controlled trials may range between US$150,000 and US$200,000.

Tools:
The significant advances in PC hardware that have been made over the last five years are transforming PC-based VR into a reality. The cost of a basic desktop VR system has decreased by thousands of dollars since that time, and the functionality has improved dramatically in terms of graphics processing power. A simple immersive VR system now may cost less than US$6,000 without the software.

To support the use of VR in mental health care, the Applied Technology for Neuro-Psychology Lab, in cooperation with the VEPSY Updated project, the VRHealth Company and the Interactive Media Institute launched the VRTherapy Project (http://www.cybertherapy.info; http://www.vrtherapy.org) whose main goal is to provide free advanced VR software to qualified therapists. The first available VEs will support the treatment of Panic Disorders. In particular, it will be possible to download the following off of the project's site:

- pre-tested virtual environments (VEs) together with their therapeutic protocols and the results of their use in controlled clinical trials;
- customizable virtual environments. The therapist, using an on-line interface, will be able to add his/her own images.

The distributed software will be available for both PCs and Pocket PC PDAs.

Conclusions:
In most circumstances, the clinical skills of the therapist remain the most important factor in the successful use of VR systems. It is clear that the free availability of different virtual environments is important so therapists will start to apply these tools in their day-to-day clinical practice. The VRTherapy projects aims at supporting this possibility.

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Presenter: Albert A. Rizzo, Ph.D.

Data, Development Issues and Future Visions from the USC Integrated Media Systems Center Virtual Environments Laboratory

Albert A. Rizzo[1], Todd Bowerly[2], Maria Schultheis[3], J. Galen Buckwalter[1], Robert Matheis[3], Greg Reger[2], Ulrich Neuman[1], and Cyrus Shahabi[1]

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2. Fuller Graduate School of Psychology
3. Kessler Medical Rehabilitation Research & Education Corp. (KMRREC)

The Virtual Environments (VE) Laboratory at the University of Southern California (USC) continues to evolve its research program aimed at developing graphics-based virtual reality (VR) technology applications for the study, assessment, and rehabilitation of cognitive and functional processes and pain distraction in children. Our development work also includes 360 Degree Panoramic Video environments designed to address Anger Management and Social Phobia. We will review the status, issues and results from studies using the Virtual Classroom, Virtual Office, Virtual Pain Distraction Scenario and our Panoramic work.

Highlights to be presented include:

1. Virtual Classroom – Development of a package of 11 cognitive tests, a head tracked performance record visualization tool and issues surrounding commercial development. This will also include a presentation of the latest version of our Psychological Corporation application and early results from the prototype testing and standardization trials.

2. Virtual Office – Review of the Data from a completed study at the Kessler Medical Rehabilitation Research Center comparing traumatic brain injured subjects with normal controls on an ecologically valid measure of everyday memory performance.

3. Virtual Home – Demonstration of a NEW environment created with advanced gaming development toolkits that are being applied at two sites to study prospective memory patients with TBI and Parkinson's Disease.

4. Pain Distraction Scenario – Data from an "art-based" VR scenario being tested with children who are fearful of venipuncture procedures.

5. Panoramic Video applications – latest development status of Anger and Social phobia applications that involve "blue-screen" capture of human characters that can be realistically pasted into fixed scenario backgrounds. This will include the discussion of projects at two sites that are testing emotional arousal in the anger management scenarios.

6. Commercial trials and tribulations – this part of the talk will cover some of the issues we have encountered with efforts to develop commercial applications. This non-traditional presentation will cover a wide range of topics with key findings and observations in each area being briefly reviewed.

Presenter: Genevieve Robillard, M.Sc.

The Relationship Between Anxiety and Presence

Genevieve Robillard, M.Sc., Stephane Bouchard, Ph.D., Thomas Fournier, Ph.D., & Patrice Renaud, Ph.D.

Cyberpsychology Lab of the University of Quebec in Outaouais (Hull, Quebec, Canada).

Research status: Complete

Background:
VR can be used to provide therapeutic exposure to phobogenic stimuli for phobic clients. Some researchers use the intensity of emotional reactions in VR as indices of the sense of presence (e.g. Meehan, 2001), while others argue that presence and emotions are totally independent concepts (i.e. orthogonal constructs; Slater, 2003). The goal of this study is to assess the relationship between anxiety and presence in order to shed some light on this debate.

Method/Tools:
Thirteen phobic participants and 13 non-phobic control participants were immersed in a 10-minute phobogenic task. The virtual environments were generated on a Pentium III® 866 Mhz PC and displayed in an I-Glass® HMD. Tracking was provided by an Intertrax^2® tracker.

Results:
Results indicate evidence of a synergistic relationship between presence and anxiety, as well as a greater tendency for phobics to experience both anxiety and presence. Correlations and regressions also show that anxiety is associated with presence. A linear regression was performed with mean Presence (dependant variable) and eight variables (e.g. anxiety, immersive tendencies). Results indicate that Anxiety self-ratings were the most important predictor (part correlation = .33). A stepwise regression was performed with mean Presence self-rating (dependent variable) and the eight other variables. It was found that the optimal model used only mean Anxiety to predict mean Presence (part correlation = .741). Stepwise regression was performed with mean Anxiety as the dependent variable. This time, the FSS-II-F *Total* scale was entered to represent the pre-exposure anxiety scales, and the ITQ-F scales and post-exposure scales were entered in a stepwise fashion. The optimal model produced by this procedure included three predictors: FSS-II-F *Total*, mean Presence, and ITQ-F *Total* with part correlation coefficients of .251, .506, and .287 respectively. Anxiety is highly correlated with Presence, and it is the best predictor of Presence.

Conclusion:
These results indicate that anxiety at the time of the VR experience is closely related to sense of presence. We also agree with Slater's contention that emotion and presence are conceptually distinct, but these results indicate that they are linked empirically and not orthogonally. Although this study has demonstrated an empirical link between emotion and presence, the underlying reason for this link remains unclear. There are at least three causal models that are consistent with this study's results that will be suggested. Further research is required to distinguish between these models. Experiments are planned in which anxiety and presence will be manipulated independently to show if either factor causes the other.

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Presenter: Catherine Sabourin

The impact of instructions on the feeling of presence during virtual immersions

Catherine Sabourin, B.A. & Stéphane Bouchard, Ph.D.

Cyberpsychology Lab of the University of Quebec in Outaouais (Hull, Québec, Canada)

Research status: In progress

Background:
The application of virtual reality in the treatment of mental disorders is quite recent and it already seems to be an efficient method, especially for anxiety disorders. However, to be efficient it is necessary that the client feels immersed and present in the virtual environment. For this rea-

son, therapists are using different strategies to foster presence, such as giving a context for the immersion (e.g., you are going to take a flight from San Diego to LA) or making suggestions (e.g., be careful not to fall from the cliff, the audience is listening to you now). The goal of this study is to assess the effect of different types of instructions on the feeling of presence: minimal instructions, the addition of a story context, the addition of suggestions about senses "felt" during the immersion or a combination of all three. Our hypothesis is that giving a context to the immersion and making suggestions about the senses stimulated during the immersion should increase the feeling of presence.

Method/tools:
The virtual immersion was conducted using a Windows-based environment running on a Pentium III (866 MHz) equipped with a ATI Radeon 64 video card, an I-Glass VGA HMD (640 X 480), an Intertrax2 motion tracker and a joystick. The virtual environment was created by modifying the map *The Temple of Horus* from the 3D game *Unreal Tournament.* During the experiment, participants had to visit a practice virtual environment for two minutes to become familiar with how to use the controls, and then follow a guided tour of the Temple of Horus for five minutes. Four experimental conditions were provided for the guided tour: (a) minimal instructions (MIN; "Please visit the Temple of Horus by following the candles that are lit to guide you"); (b) minimal instructions and a story that gives a context to the immersion in the virtual environment (STORY; a description of the Egyptian god Horus and the history of his temple); (c) minimal instructions and suggestions about the senses stimulated by the virtual environment (SUGG; e.g., "be careful not to fall when going down the stairs, it is slippery"); (d) minimal instructions, information about the context of the visit, and suggestions about the senses stimulated by the virtual environment (ALL). Participants were randomly assigned to the four conditions and completed measures of immersive tendencies, presence, realism and cybersickness.

Results and Conclusions:
The preliminary results of this study (still in progress, N=57 adults from the normal population) failed to show any significant differences on the measures of presence between all four conditions. Thus, it seems that what is said by the experimenter during an immersion in a virtual environment may not have a strong impact on the participant's feeling of presence. These results highlight the importance of factors that are contributing to feelings of presence, such as quality of the interface, possibilities of interacting with the virtual environment, or the number of senses stimulated by the virtual environment.

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Presenter: Cristian Sirbu, Ph.D.

How Active are Fear Structures During Exposure in Virtual Environments? A Test of Emotional Processing Theory in Acrophobia

Cristian Sirbu1,2, Thomas H Ollendick1 & Thompson E. Davis III1

1. Virginia Polytechnic Institute and State University
2. Babes-Bolyai University, Cluj-Napoca, Romania

Background:
According to Lang (1979), fear is represented in memory as informational structures including (1) information about feared stimuli, (2) information about verbal, physiological and motor responses, and (3) information about the meaning. The effective treatment for specific phobias involves modification of these informational fear structures through "emotional processing" (activation and modification of the structures through guided exposure and provision of information incompatible with the preexisting one). An important parameter for emotional processing is the degree of activation of the fear structures during exposure, which depends on the number of systems involved. An optimal level is achieved when every response system is active, with the patient expressing physiological arousal, self-reported fear and avoidance.

The efficacy of Virtual Reality Exposure Therapy for the treatment of specific phobias is well documented in the literature (Glantz et.al, 2003, Wiederhold & Wiederhold, 2003, Rothbaum et al, 2002). Although the outcomes are compelling, the literature is lacking regarding the degree to which the exposure to virtual environ-

ments produces activation of the fear structures, an important precondition for emotional processing.

Based on these assumptions, this study (currently in progress) presents a procedure for the assessment of activation of fear structures during exposure to a virtual environment designed for the treatment of acrophobia.

Method:
Fifteen subjects diagnosed with acrophobia using ADIS-IV and 15 control subjects without acrophobia were involved in the study.

Two levels of exposure to stimuli from a virtual environment were used. First, subjects were exposed to a pictorial Stroop task using pictures associated with heights and neutral pictures, both taken from virtual environments. For the Pictorial Stroop task, the degree of activation for fear structures was operationalized as the interference and the physiological activation during the task. Second, subjects were exposed to a Virtual Reality Behavioral Avoidance Test (VR-BAT) (using the same environment the picture was taken from for the Stroop task). During the test, the degree of activation in the fear structures was operationalized as the number of steps completed (a measure of avoidance), the self-reported fear (Subjective Units of Distress), the level of confidence and the physiological activation.

For control purposes, subjects were also exposed to an In Vivo Behavioral Approach Test (IV-BAT). In this case, the degree of activation of fear structures was investigated using the same self-report measures as in the VR-BAT.

Results:
Compared to the control group, the acrophobics showed increased interference and physiological reactivity during the Stroop task, as well as increased avoidance, self reported fear and physiological arousal during the virtual and in vivo BAT. The degree of reactivity was similar in the virtual environment to the real one.

Conclusions:
The exposure to virtual environments produces a level of activation for fear structures comparable to the level elicited by in vivo exposure. Based on these results, a procedure for designing virtual environments able to induce an optimal level of activation for fear structures is presented. Implications for optimization of treatment using virtual environments, in terms of the duration of exposure and selection of the most relevant stimuli, are discussed.

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Presenter: Julie St-Jacques

Long-Term Effectiveness of *In VR* Exposure for Phobic Children

St-Jacques, J., B.A.[1], Bouchard, S., Ph.D.[2], & Renaud, P., Ph.D.[2]

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2 University of Quebec in Outaouais

Research status: Complete

For approximately 10 years, clinical psychology has seen the emergence of a new avenue of treatment: virtual reality. This technology has been used, among other things, to treat anxiety disorders. There is now a growing body of scientific studies assessing the effectiveness of virtual exposure (VR) for the treatment of arachnophobia in adults (Carlin, Hoffman, & Weghorst, 1997). This alternative treatment offers multiple advantages: it favors confidentiality, it is safer and it could be less expensive. Since preliminary data of this VR treatment for arachnophobia in children was presented last year, the focus of this presentation will be on the long lasting effects showed six months after the end of the program.

The goal of this study is to assess the effectiveness of VR exposure for arachnophobia in children. This study relies on a single case design with multiple baselines across subjects. The sample consists of seven females and one male. The subjects, aged between 8 and 16 years old, were SCID-diagnosed to confirm the presence of arachnophobia. Participants were randomly assigned to one of three base line levels: three, four or five weeks. Participation in

the study involves six sessions of approximately 75 minutes, of which five sessions are weekly based. The first session is to confirm that all of the participants meet the inclusion and exclusion criteria of the study. The second session provides participants with the necessary information to successfully complete the program (informed consent, information about phobias and avoidance, etc.). The last four sessions consist of VR exposure. The exposure was administered using a standardized treatment protocol. Self-monitoring of fear of spiders has been conducted weekly before, during and after the treatment with the children and their parents. At pre-treatment, post-treatment and six-month follow-ups, the participants also filled out a series of questionnaires: the Immersion Tendency Questionnaire, the Depression Self-Rating Scale, the Fear of Spider Questionnaire and the Fear Survey Schedule.

Results are very positive and suggest that: a) virtual reality exposure might be helpful with children, b) the gains are maintained over time, c) it is safe to conduct virtual reality with children (an issue sometimes raised by Ethics Review Board), and d) larger group-based studies are warranted.

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Presenter: Dorothy Strickland, Ph.D.

Evaluating a Video Enhanced Virtual Reality Program for Teaching Restaurant Social Skills to Children with Autism

While Virtual reality has been used for various training applications, few studies have measured its effectiveness in teaching social interactions. This research used web delivered gaming technology to create virtual worlds where children with Autism Spectrum Disorder (ASD) interacted with avatars to practice appropriate restaurant social skills. Videos of similar real world situations were introduced within the virtual sequences to reinforce the lessons and aid in generalization, a known problem for individuals with ASD. Before training, two unknown restaurant social skills were identified for each of six children with ASD, aged 7 to 16. After virtual world training, all six children correctly performed the two new social skills while in the virtual restaurant, and four children exhibited appropriate social interactions in post-training real world restaurant settings.

Presenter: C. Barr Taylor, M.D.

The Use of an Internet Based Program to Prevent Eating Disorders

Andrew Winzelberg, Ph.D., Kristine Luce, Ph.D., Jennifer Brown, Ph.D., Smita Das, Christine Celio, M.A., Parvati Dev, Ph.D.

Stanford Medical Center, Stanford, CA USA

Research Status: Completed clinical trial and work in progress.

Background:
Although prevention of both eating disorders and obesity is strongly recommended, combining eating disorder and obesity prevention interventions for defined populations, such as middle and high school students, is complicated. For instance, population-based interventions must be appropriate for all students in the classroom, including those who do not have risk factors for either eating disorders or obesity and the intervention should not stigmatize any students. This paper discusses two studies aimed at developing universal and targeted interventions that aim at preventing eating disorders and obesity.

Methods:
Both studies involved all 10th grade students enrolled in an all-girls public school in Northern California. In both studies, all students completed *Student Bodies*, an 8-session on-line psychoeducation program, linked to a discussion group. The program provides didactic information, encourages self-monitoring and journaling and is linked to a moderated discussion group. Students are assessed pre- and post-treatment using standard self-report instruments to assess eating disorder attitudes and behavior. In the first study, students were randomized by class to the intervention (n=102) or control

(n=51); parents were provided an on-line discussion group and handout. In the second study, all students taking health education were assessed on-line, provided feedback and recommendations as to the intervention appropriate to their risk level.

Results:
In the first study, students in the intervention reported a significant reduction in restrained eating (an indication of eating disorder risk), but the effects were no longer significant at follow-up and a significant increase in knowledge. Parents using the on-line program reported a significant increase in being less critical to others and in their own outlook on life compared to the control group. In the second study, 174/188 students elected to participate in this study and were assessed online. The algorithm identified 111 no-risk (NR), 36 eating disorder risk (EDR), 16 overweight risk (OR), and 5 both risks. Fifty-six percent of the EDR and 50% of the OR groups elected to receive the recommended targeted curricula. Significant improvements in weight and shape concerns were observed in all groups; effect sizes in the high-risk participants were in the moderate range (0.3-0.7). Of the 11 students who reported self-induced vomiting and/or laxative use baseline, seven denied self-induced vomiting or laxative use and three participants fell below the threshold level at follow-up. One participant reported continued self-induced vomiting, but reported that she had initiated psychotherapy because of her participation in the program.

Conclusions:
An Internet-delivered program can be used to assess risk and provide simultaneous universal and targeted interventions in classroom settings. Participation in the intervention is associated with significant improvement in eating disorder attitudes and behaviors.

Novelty:
These and earlier studies are the first controlled studies of on-line eating disorder prevention programs and the first to address issues of on-line risk assessment and allocation to intervention based on risk. They demonstrate the feasibility of combined universal and targeted interventions for defined populations.

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Presenter: Sharon Tettegah, Ph.D.

Assessing Perceptions and Empathy of Victims in Educators

Research Status:
This study presents preliminary data from clinical trials currently under investigation using web based and a supercomputing Access Grid to assess perceptions of victims and victim empathy of pre-service teachers. The Access Grid is

an experimental system that brings people together by linking high speed hardware, cutting-edge applications, multimedia displays, and high end audio and video technology into an efficient persistent computing and communications technology (http://www.accessgrid.org).

Multimedia can be a powerful means to deliver representations of social behaviors. Little research has examined student perceptions of victims and victim empathy of pre-service teachers. Much work has been done on victim empathy of sex offender and empathy as an interpersonal phenomenon, but little has focused on the necessary understanding of empathy and perceptions of student victims in classroom environments (Hakansson, 2003; Webster, 2002). This study investigates (1) perceptions of the victim; (2) to reveal the level of empathy that pre-services teachers have for the victim; (3) to understand the strategies of action suggested by the respondents; and (4) the type of behavioral change focused on by the respondent.

Methods and Tools:
This exploration reports preliminary results from narratives based on actual school experiences that are developed into animated multimedia vignettes. Seventy-eight pre-service teachers were exposed to a multimedia animated vignette narrative depicting a discrimination situation in a classroom environment (Fine & Weis, 2003). The pre-service teachers responded to the narratives by assuming the role of one of the characters (Fencott, 2001). Creswell (1998) writes about case study sampling as "bounded by time and place" (p. 37). Utilizing a case study approach allows for a better understanding of the text in a quantitative and qualitative manner (Rosen, Woelfel, & Barnett, 2002).

Results:
The results are reported by the following categories: expression of concern, empathy, strategy, focus of behavioral change and management focus. The respondents expressed concern for: Scott 29%; Jamilah 4%; Mr. Young 46%; Ms. Litts 11%; the class 83%; themselves 6%. Who does the respondent express empathy with? In whose position is the respondent able to imagine themself? Scott 11%; Jamilah 14%; Mr. Young 6%; Ms. Litts 14%; the class 6% What are the strategic actions suggested by the respondent? How do they suggest they would deal with the immediate situation? (Immediate): Express concern 63%; Thank Mr. Young 9%; Assure Mr. Young 51%; Apologize 34%; take a side 3%; doubt the claim 3%; invite parental input 34% (Longer term): Class lesson and/or discussion 89%; talk to Scott 49%; isolate and/or discipline Scott 14%; force Scott to apologize to Jamilah 6%; treat as an isolated incident 6%; make a conscious effort to not isolate Scott, Jamilah, or the incident 20%; talk to Jamilah 20%; empower Jamilah 14%; talk to Scott's parents 31%; hold a group meeting with concerned parties 6%; follow up 14% What type of behavioral change does the respondent focus on? Proper conduct 51%; Correct Information 29%; Proper speech 20%; Proper thought 14%; fostering empathy 9%. What interpersonal situation is the respondent most concerned with managing? With whom does the respondent focus their managerial expertise? Scott 46%; Jamilah 17%; Mr. Young 74%; Ms. Litts 3%; the class 89%; Scott's Parents 20%.

Conclusions:
The findings from the data set are extremely important in understanding our approach towards teaching and learning. It also helps us to understand how educators think about problem solving with issues that are related to understanding perceptions of victims and victim empathy, as well as other issues, which occur in the classroom and school environments. Further analyses can reveal more on the nature of empathy towards students that are victims in the classroom environment.

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Presenter: Cheryl Y. Trepagnier, Ph.D.

Design Trials of the Virtual Buddy: Progress Report

Marc M. Sebrechts, Ph.D.[1], Maya Coleman, M.A.[1], Andreas Finkelmeyer M.S.[1], Rameshshandra Ramloll, Ph.D.[2], Linsey Barker, B.Sc.[2], Corinna Lathan, Ph.D.[3], DC; Maxwell Vice, B.Sc.[3], Matthew Pettersen, B.Sc.[3]

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2. National Rehabilitation Hospital, Washington, DC, USA;
3. Anthrotronix, Inc., College Park, MD, USA.

Research Status: In Progress.

Background:
Face processing impairment is common in autistic spectrum disorders (ASD) (e.g., Klin et al., 1999; Trepagnier, et al., 2002). The objective of this design project is to produce an environment for delivery of an early intervention to train social gaze based on the hypothesis that the inability to process nonverbal communication contributes to the depredations of autism (Trepagnier, 1996).

Method:
An arcade 'police helicopter' (the pod) has been adapted. The child's gaze, sensed by an ISCAN tracker, is the input. Visual, auditory and vestibular stimuli (rides) are provided as enticements and rewards for gains in more functional social gaze, in a voluntary play context. Positive consequences will ensue when the child gazes at the Virtual Buddies' faces, and when that gaze shows an interpretation of face-borne information (e.g., following the Buddy's gaze direction). Issues of concern in the design of this environment include appeal, ease of entry and egress and adequacy of positioning for successful tracking. Nine 'neurotypical' children and 4 children with ASD or suspected ASD, mean ages 4, each accompanied by a parent (with one exception) have participated. Questionnaire and Likert scale responses were obtained from the 12 adults, and most children (who, however, treated the scale as a binary choice). Data is being compiled and analyzed. A semi-automated calibration (semi-autocal) routine has been devised. Once a good eye image is visible, the investigator triggers semi-autocal: the monitor goes blank and a small figure appears in the next location. After 250 ms. gaze coordinates are automatically acquired and the video display resumes. This is done to collect each of the 5 points required, in order for Iscan calibration, and is spread out over time to reduce risk of boredom. Appealing video has contributed to capturing and holding the child's attention, and thus acquiring eye tracking data. The next pod iteration will include changes in the relative angle of the tracking camera and the car seat, and means for encouraging stable head position (e.g., a light pressure switch embedded in the seat back, so that the video is enabled (or brightens) only when the child's back is in contact with the seat back).

Results:
Data is continuing to be acquired and reviewed. While all children report enjoying the ride, they differed in respect to how often and how long they wanted to experience it. Repetition of video material quickly lost the attention of 'neurotypical' children, but not of children with ASD. Tolerance for calibration was low, requiring careful management.

Conclusion:
A preliminary inference is that it will be important to use rewards, including preferred video for each child with ASD, not just to reinforce target behavior, but also to maintain the child's participation. Buddies will introduce, praise, enthuse, and provide the gaze training opportunities that video and other preferred experiences and objects will need to reward differentially.

Novelty:
In relation to the conceptual presentation of-

fered last year we will present data, including some video, from 13 'models' of the end user, resulting in changes, recommendations for change, and the validation of the concept.

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Presenter: Veronique Vaillancourt Ph.D.

Use of audio VR to evaluate functional hearing abilities in the workplace

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Many jobs are hearing-critical and have several features in common: they are often performed in noisy environments and involve a number of auditory skills and abilities, such as verbal communication, sound localization, and sound detection. If an individual lacks these skills and abilities, it may constitute a safety risk for this individual, as well as for fellow workers and the general public. Predictions of performance on these auditory skills are often based on diagnostic measures of hearing, such as pure-tone audiograms. These measures are unable to provide accurate predictions of real life performance with the auditory skills necessary to perform hearing-critical jobs. In our research, we have used more direct measures of functional speech perception in noise (Hearing in Noise Test: HINT) and sound localization in noise (Source Azimuth Identification in Noise Test: SAINT) for screening applicants for hearing-critical jobs. These screening tools can be used under headphones or in a sound field (using loudspeakers). Since, it is not always possible to have access to a sound proof room large enough to use loudspeakers, and since the sound field testing is sensitive to wall reflections, the use of headphones is a preferred method. In order to reproduce the direction of noise and sound stimuli (speech or environmental sounds) and to make use of the binaural hearing system under headphones, we used audio VR technology. With this more accurate approach, it is now possible to test functional hearing abilities in clinical settings and make judgments on the ability of people to perform real world auditory tasks. Validation data (N of subjects= 90) for a Canadian Coast Guard environment will be presented.

[Project funded by Fisheries and Oceans Canada, Contract F7053-000009]

Presenter: Mattias Wallergård, MScEE and Licentiate in Engineering

Can People with Brain Injury Transfer Route Knowledge from a Virtual Environment to the Real World?

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2. Department of Rehabilitation, Lund University Hospital, Sweden

Research status: In progress

Virtual Environments (VE) are presumed to have the potential to become a complement to conventional training tools in brain injury rehabilitation (Davies, Johansson, Boschian, Lindén, & Minör, 1999). Possible application areas include the assessment of process skills and

training in daily living tasks such as shopping, cooking, and using a telephone. Studies by Cromby, Standen, Newman, Tasker (1996), and Mendozzi et al. (2000) suggest that it is possible for people with cognitive impairments to transfer skills from a VE to the real world. However, there is a need for further research to understand how and to what extent people with brain injury can use skills achieved in a VE in a real situation. To learn more about this, we are currently conducting an experiment that aims to investigate how people with brain injuries can transfer route knowledge from a spatial navigation task in a VE to a real environment.

Six able-bodied people and six people with brain injuries participated in the experiment. The task of the subjects was to find their way to a certain location in the Department of Rehabilitation at Lund University Hospital after having practiced in a virtual version of the environment. The VE was built using the 3D game editor WorldCraft, and the experiment was done with a standard PC and a regular monitor. Video recording in combination with a retrospective verbal protocol technique was used to get information on the subject's cognitive process. This means that the subject commented upon his actions, while watching the video recording from the trial.

So far, the experiment has been conducted with six able-bodied subjects and three people with brain injury. All able-bodied subjects managed to find their way without getting lost or hesitating on the way. The first brain injury subject had mild memory and concentration problems. He managed to find his way without any problems. The second brain injury subject had mild memory and attention problems. He got confused and hesitated at two occasions but managed to find his way to the location. Finally, the third brain injury subject had severe memory problems. She hesitated at two occasions but managed to solve the navigation task.

The most interesting result so far is that the third brain injury subject managed to find her way. Her occupational therapist was utterly convinced that she would fail due to her severe memory deficit. Our hypothesis up until now has been that only brain injury patients with mild and moderate cognitive deficits can transfer skills from a VE to the real world, but now we are starting to believe that even patients with severe disabilities might benefit from VE training.

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Presenter: David G. Walshe, Ph.D.

Can MVA victims with driving phobia be immersed in computer simulated driving environments?

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Status: Ongoing

In an earlier study we showed the effectiveness of computer-generated environments in exposure therapy for the treatment of driving phobia following motor vehicle accidents (MVA). Seven treated patients showed a marked reduction in driving phobia severity (p=0.008) as well as reductions in PTSD severity ratings (p=0.008) and depression severity (p=0.031)[1]. However, 50% of the cohort of patients screened in this study did not immerse in the simulated environments and therefore could not undertake therapy. This sets limitations on the use of virtual reality exposure therapy (VRET) as a treatment modality for driving phobia.

Objective:
To investigate if an acceptable immersion rate (>80%) can be achieved for subjects with driving phobia in computer generated environments involving modifications in the VR program and augmented reality through: projection of images onto a large projector screen, visualizing the screen through a windscreen and increasing vibration sense through stronger subwoofers.

Design:
12 patients referred from the Emergency Department of a general hospital or from a general practitioner following a motor vehicle accident who met DSM-IV criteria for Simple Phobia/ Accident Phobia were exposed to a Virtual Driving Environment (*Hanyang University)* and computer driving games (*London Racer/Midtown Madness/Rally Championship*). Patients undertook a thirty minute trial session in driving environments of graded difficulties in a darkened room. SUD ratings and heart rate measurements were taken at five minute intervals. "Immersion," i.e. a sense of presence with heightened anxiety in the driving simulations, was operationally defined as in our earlier study as an increase in SUD ratings of >3 and/or an increase of heart rate >15 BPM in computer simulation driving.

Results:
Results will be presented at the Cybertherapy conference together with video presentations of the VR/GR environments.

Novelty:
This is a novel study in the area of VRET for driving phobia. Findings have implications for the clinical use of VRET in driving phobia.

Walshe, D.G., Lewis, E.J., Kim, S.I., O'Sullivan, K., Wiederhold, B.K. (2003). Exploring the Use of Computer Games and Virtual Reality in Exposure Therapy for Fear of Driving Following a Motor Vehicle Accident. *CyberPsychology & Behavior: The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society.* 6(3): 329-334.

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Presenter: Leo Sang-Min Whang, Ph.D.

On-line Game Addiction as a Luxury syndrome: An immersion of the digital world as a consumption of digital product

Leo Sang-Min Whang, SeJin Heo, MiYeon Hur

Research status: Complete

An excessive participation in the on-line gaming world is defined as game addiction. However, this immersion in the on-line game world characterizes not so much the addiction to the 'on-line game world' product, as an immersion in the digital world itself. This phenomenon seems to be not only the excessive use of the on-line game as a digital product, but the active participation in the digital world. We assume the excessive use of on-line games is directly related to the phenomena of 'luxury syndrome'. This research investigated how the recognition of the commercial value of on-line game worlds and satisfying the needs of game users is related to the degree of participation in the on-line game world.

We conducted an on-line survey on one of the most popular on-line games, 'Lineage', in Asia. We used an "on-line game immersion" scale based on Young's Internet Addiction Scale, and 4,679 game users. Out of the total participants, the levels of participation in the on-line game world are classified as 'excessive immersion', 'potential immersion' and 'non-immersion'. Out of the subject pool, 7% had been classified into "excessive immersion", while 12% had been diagnosed as 'non-immersion' and the rest of

participants were sorted as 'potential immersion'. The degree of immersion in the on-line game world showed a strong relationship between game users' recognition of the on-line game as the digital world and their behavior characteristics. Between the two extreme groups, the results show the significant difference in terms of the endowing value of on-line game worlds. The two groups are markedly distinguished regarding the psychological desire for a human relationship fulfilled by the experiences in the on-line game world.

This research presents a different point of view, which accounts for game addiction as one of the various lifestyles designating a new type of life in digital space, not the degeneration of personal adaptive function. Consequently, the immersed behavior, like on-line game addiction, is regarded as the behavior characteristics of 'luxury syndrome'. Further study is needed to investigate interventions for game addicts in the cyber world. We suggest further research on how the degree of immersion in the digital world influences the various human behaviors and changes in thinking.

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Presenter: Brenda K. Wiederhold, Ph.D., MBA, BCIA

Clinical Analysis of 350 Patients Completing VR Therapy

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In August 1997, the Virtual Reality Medical Center (VRMC) began treating patients with fear of flying using a combination of VR and physiological monitoring and feedback; completing the first controlled study in 1999 comparing VR treatment to imaginal exposure (visualization) for fear of flying. Since that time, we have expanded our clinical services to include VR and physiology to treat a number of specific phobias, social phobia, panic disorder and agoraphobia. In addition, we now maintain active research programs using VR, simulations, robotics, the Internet and other advanced technologies in many diverse areas including: eating disorders and obesity, distraction during painful medical and dental procedures, teen smoking prevention, cue exposure, rehabilitation, attention-deficit hyperactivity disorder, autism, and quality of life applications for those with long-term illnesses. We also utilize simulation and VR for training in such wide-ranging areas as combat casualty care and teenage driving education.

This presentation will focus on our initial analysis of data from anxiety disorder patients who have completed VR therapy at the VRMC.

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Presenter: Mark D. Wiederhold, M.D., Ph.D., FACP

Training Combat Medics Using VR

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1. The Virtual Reality Medical Center

Past success using virtual reality to support training in the military has encouraged the continued exploration of new areas that would benefit from virtual training. We are exploring how virtual reality and other simulations can be applied to train combat medics for combat casualty care. Significant questions on training transfer remain to be answered, and a variety of training methodologies including virtual reality, patient mannequins, live animals, or a combination thereof are undergoing evaluation and testing. Issues such as developing metrics that measure successful transfers of training to the real world are underway by military, academic, and industrial groups. We are evaluating training transfer using simulation and virtual environments where the trainees' physiological signals,

focus of attention, and concentration are measured. Understanding the psychological and physiological state of the trainee during training exercises may provide a useful metric for gauging successful transfer of information to be used in real world situations.

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Presenter: Beth Yost

Learning to Interact with People with Disabilities Using Virtual Environments

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Research Status: In Progress

Background/Problem:
Virtual environments (VEs) have shown potential for teaching social skills to children with Asperger's Syndrome, a mild form of autism (Cobb, Beardon, Eastgate, Glover, Kerr, Neale, Parsons, Benford, Hopkins, Mitchell, Reynard, & Wilson, 2002) and for treating phobias (Hodges, Anderson, Burdea, Hoffman, & Rothbaum, 2001). However, there has been little research on using VEs to teach social skills to people without autism or phobias. Our goal was to design and implement a learning environment for teaching social skills to average people and to evaluate the usefulness of that application. To that extent, because of the typical misconceptions due to lack of previous exposure and the stereotypes surrounding disabilities, we chose to create an environment teaching participants how to interact with disabled people.

Method/Tools:
We developed our environment using the Simple Virtual Environment Library (SVE) (Kessler, Bowman, & Hodges, 2000). The implemented environment consisted of an outdoor park, a virtual person who is blind, and a guide dog. Users are guided by verbal and physical responses from the virtual person through a series of four 'do' and 'don't' guidelines. To evaluate the usefulness of the application, we used a between subjects single-factor design with twelve participants randomly assigned to one of two display conditions. The display type was either a desktop or a head-mounted display (HMD).

Conclusion /Results:
The results of a free recall question showed that the highest percentage (67%) of participants learned not to play with a guide dog. All participants reported that they were more likely to remember the guidelines after interacting with the virtual person than if they were given paper guidelines. However, when asked how comfortable they were interacting with a person who was blind, there was no significant difference between ratings provided before and after the use of the application. More was learned using the desktop than the HMD, but not significantly more.

Based on the results, we believe that people are more likely to remember the lessons after having used the application. Although the novelty of the HMD affected the perceived impact levels, the more familiar desktop displays resulted in better performance. The novelty of the HMD may have distracted the users from the task of learning social skills. Additional research is planned to determine if higher levels of interactivity result in better learning of social skills and if, based on the idea of near transfer, users would interact appropriately when confronted with a real person that is blind.

Novelty:
The potential impact of this in the future is that if it is useful for populations with normal mental capabilities, it could be extended to teach social skills to people not able to physically interact with other populations. For example, the treatment of a sexual abuser could involve interaction with virtual children.

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